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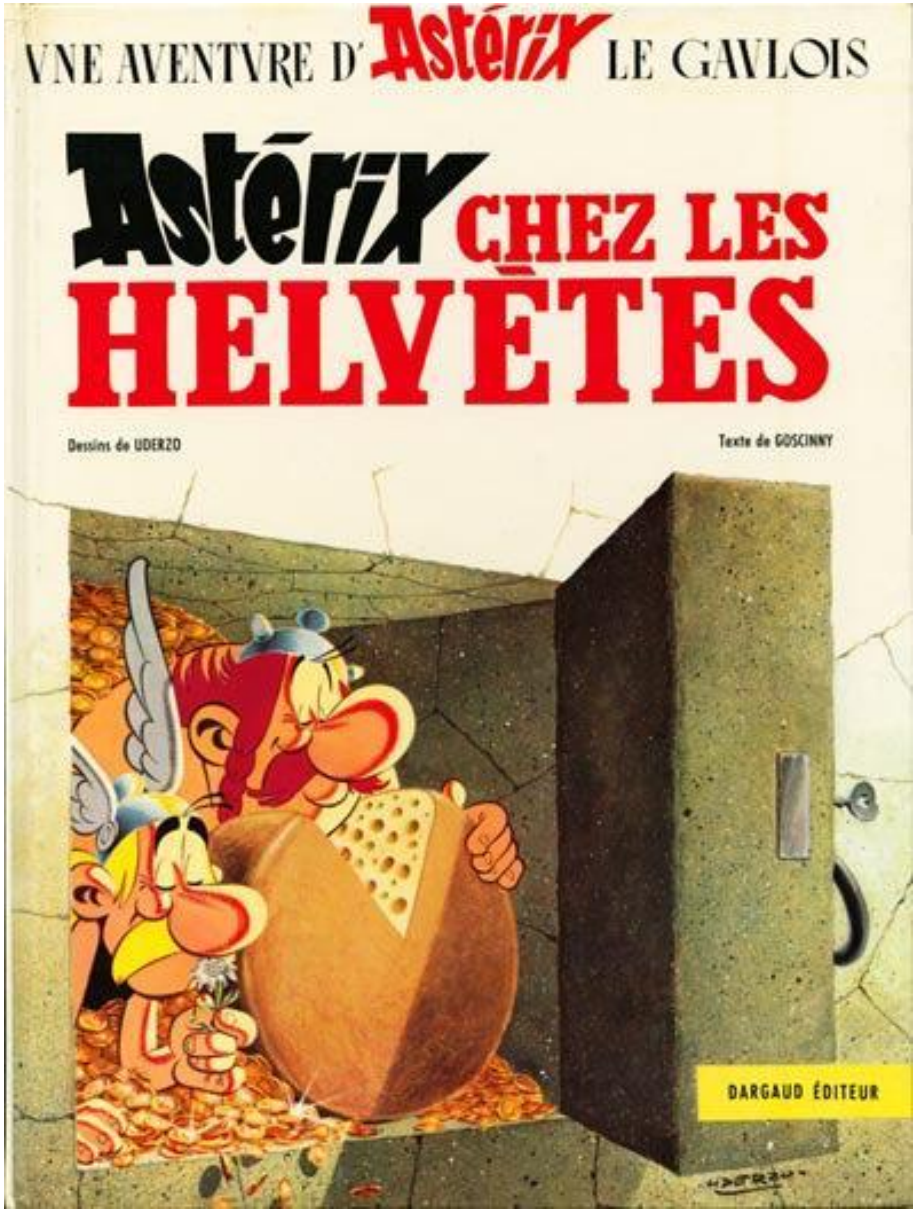
Mechanism and control of the eye formation in cheese



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Bern-Liebefeld, Switzerland

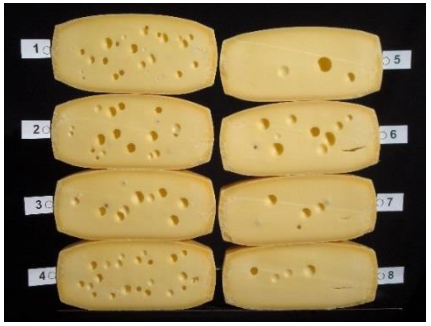
IDF Cheese Science & Technology 2016, Dublin

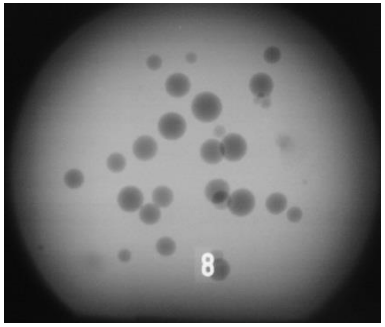
Overview

- Importance of eye formation in cheese
- Imaging methods (sectional image, X-ray, CT, ultrasound)
- Eye formation: influencing factors and theory
- Eye formation experiments
- Eye defects
- Conclusions

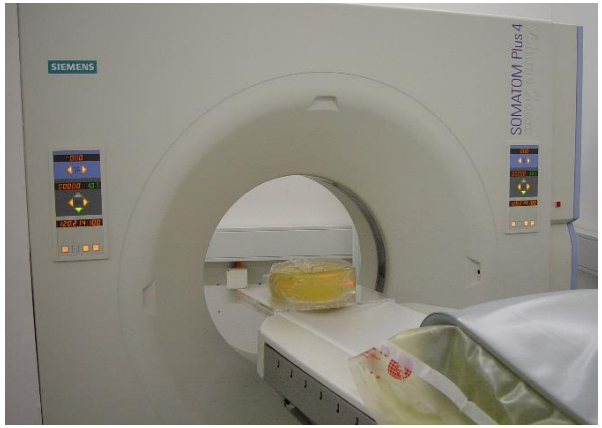
Significance of eye formation

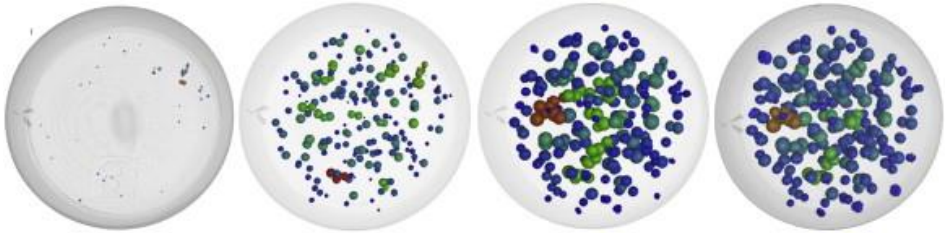
Imaging methods



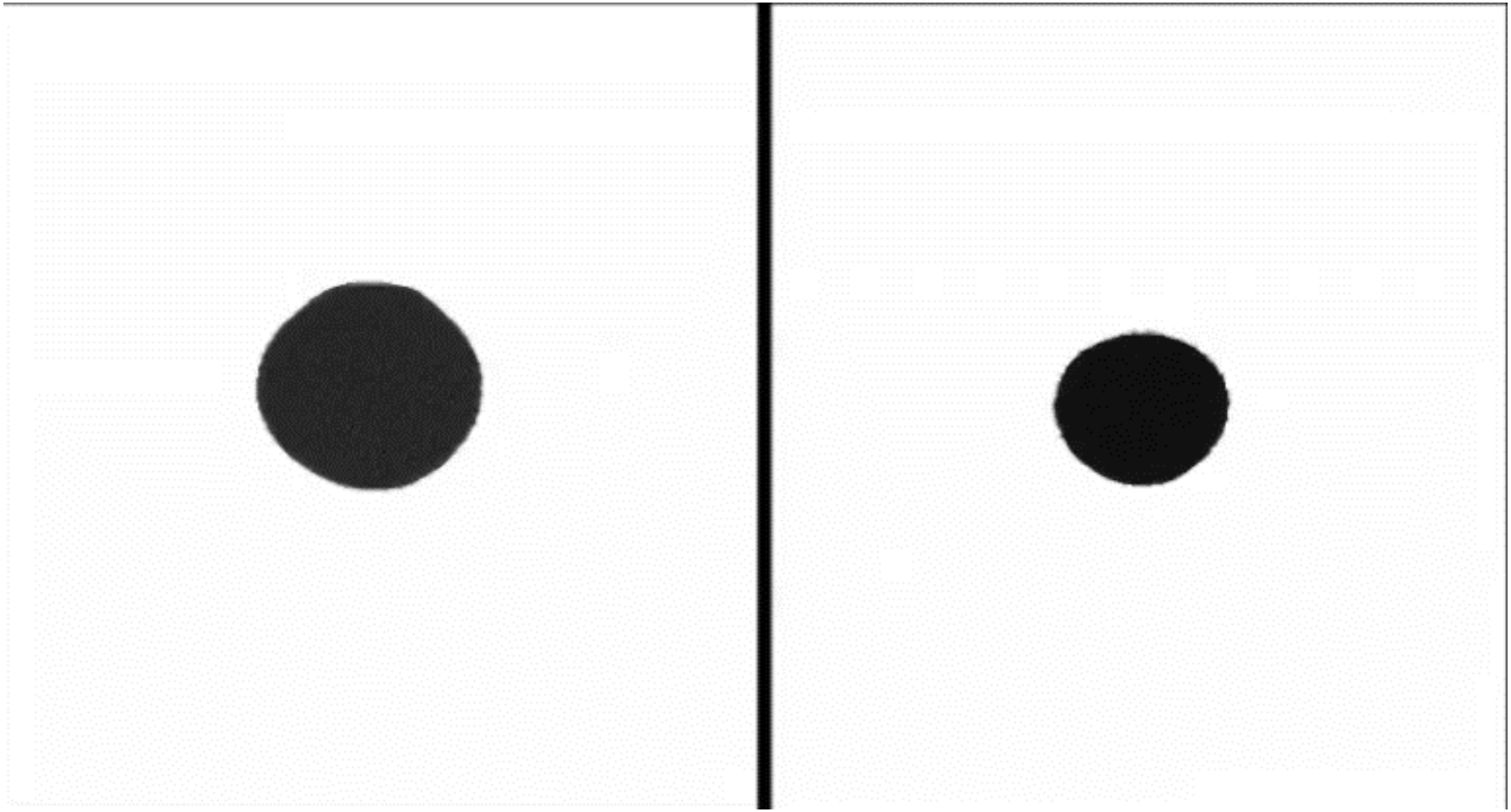


- Sectional views
- X-ray
- Ultrasound echolocation (Albrecht 1998)
- Computed tomography (Strand 1985)





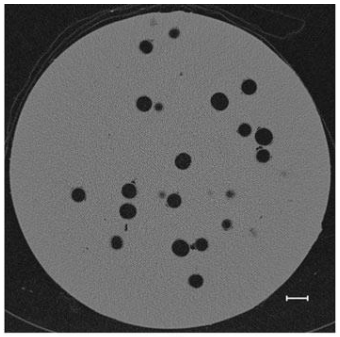
2D and 3D views from CT-scans

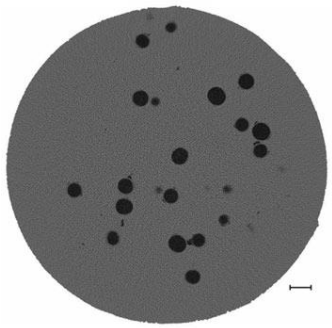


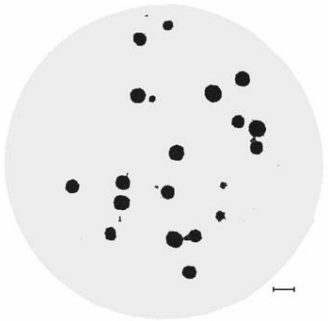
Excessive eye formation

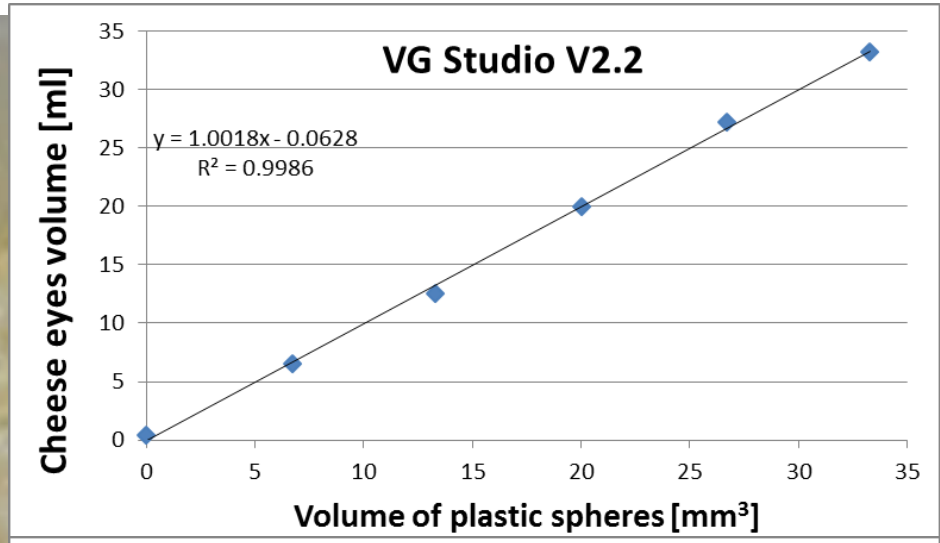
Sparse eye formation

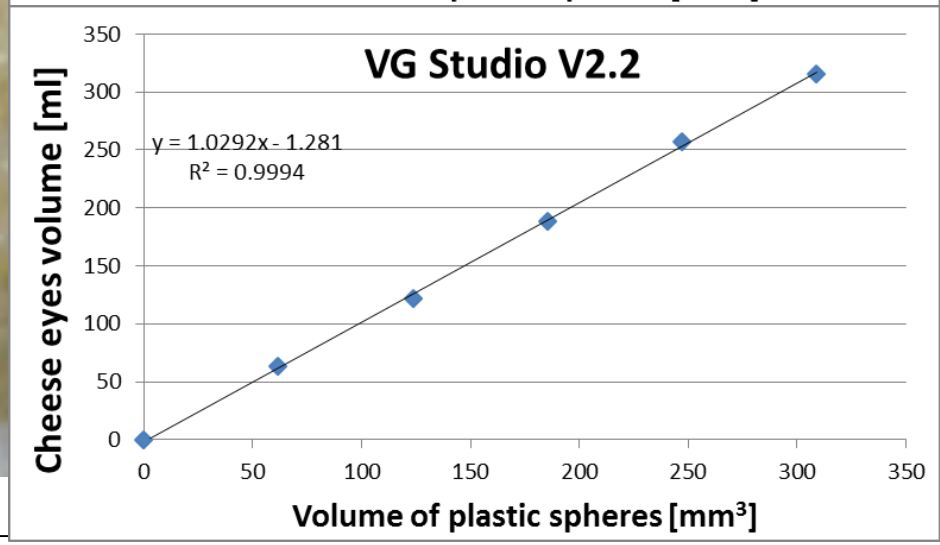
Validation of the CT method





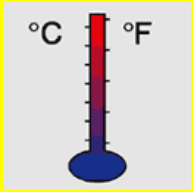






Eye formation:
Theory and influencing factors

CO_2 PRODUCING CULTURE
(SATURATION OF CHEESE)



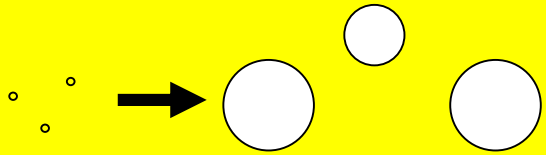
↓

CO_2 DIFFUSION

EYE FORMATION

↓

NUCLEI



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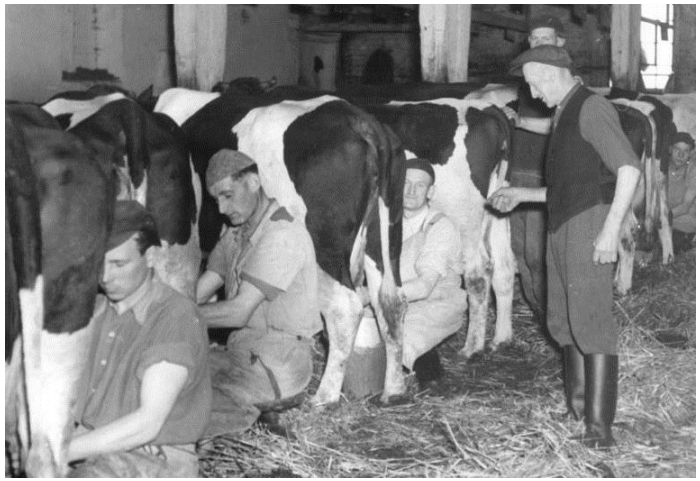
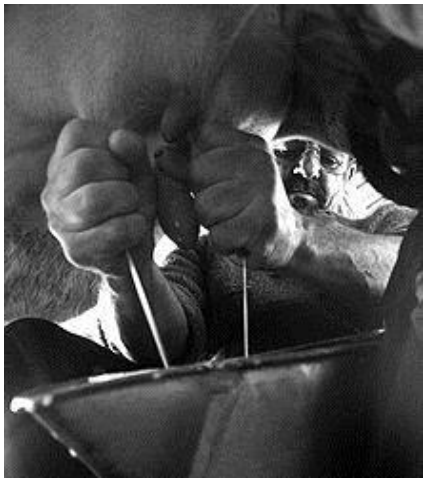
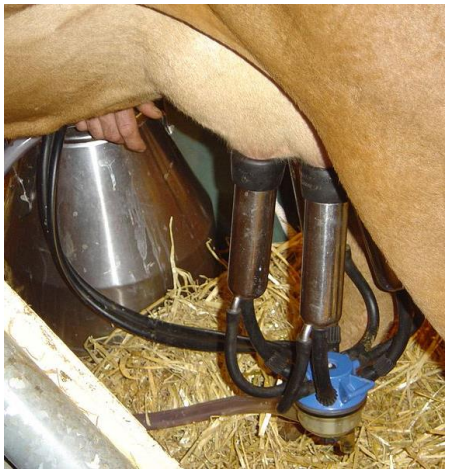
CO_2 DIFFUSION ← RIND, FOIL,…

Times are changing…

Improved hygiene in milk production

History eye formation (nucleus-theory)

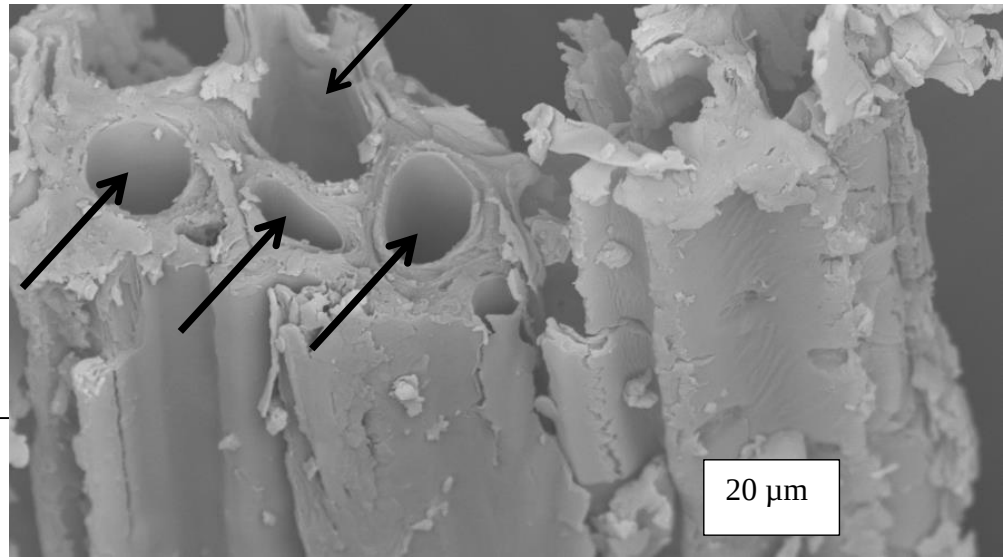
- First scientific hypothesis (beginning of 20th century):
  → «gas-building colonies», punctual oversaturation of CO_2
- Clark (Review, 1917):
  → Differences in CO_2 concentration are balanced by diffusion
  → Eyes are formed at “favoured localities”
  → Crystallisation → “seeds”, “irregularities”
  → Rain drops → “dust particles”
- Gehriger (FAM, 1970): Production in winter: more eyes, production in summer: less eyes
- Review Martley and Crow (1996):
  → microscopically small air bubbles
- Review Polychroniadou (2001)
  → Nitrogen gas in the milk, CO_2 produced from starters

Further theories:

- → Micro-particles
  → small mechanical openings (technical eye formation)
- Fragnière (Agroscope, 2004)
  - Micro-filtration disables eye formation

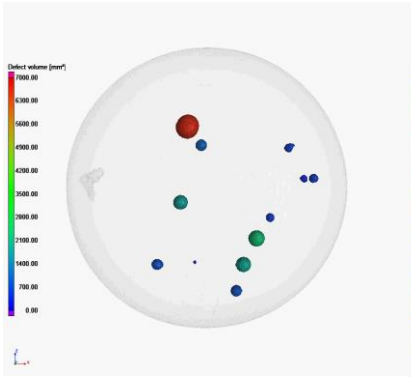
- Agroscope (2013 - 2015):
  - Hay particles and eye formation are related and define the starting point of the eye formation (Structural element as an indication!)

Cavities in hay particles allow eye seeding

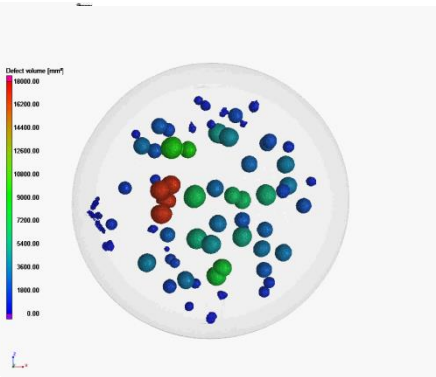


Control of eye formation

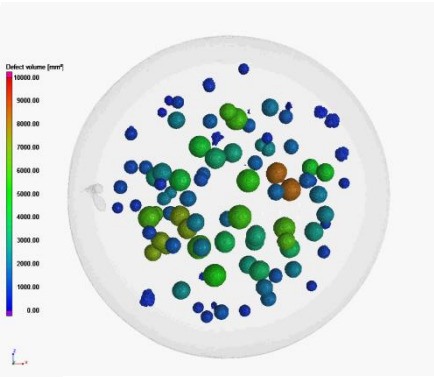
60 days



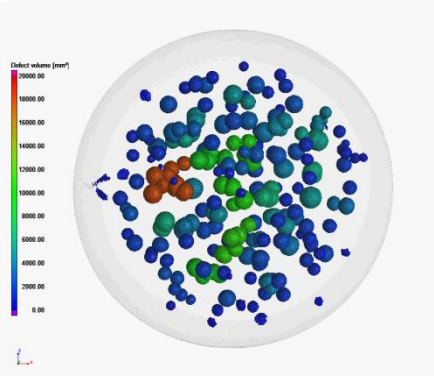
Control: 10 eyes



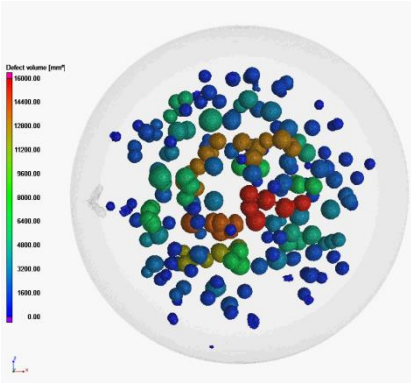
0.063 mg: 52 eyes



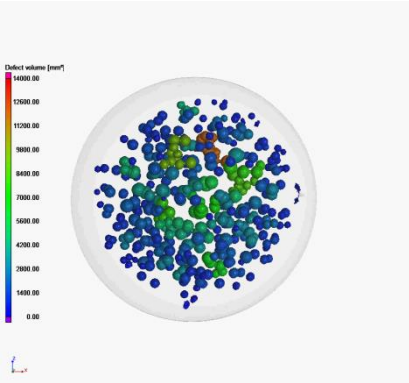
0.125 mg: 84 eyes



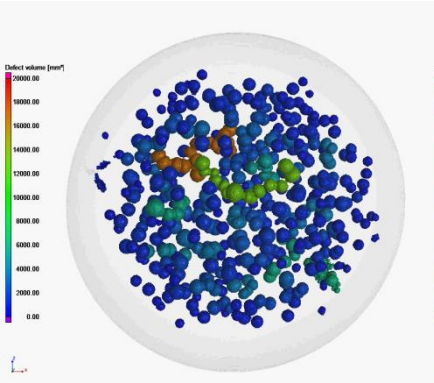
0.25 mg: 178 eyes



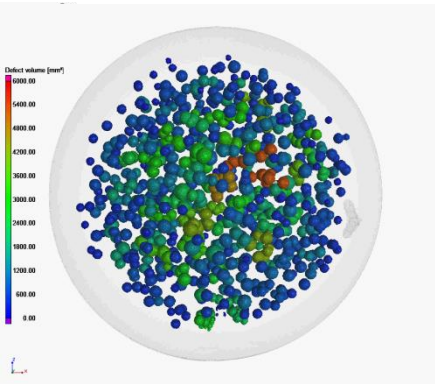
0.5 mg: 184 eyes



1 mg: 359 eyes



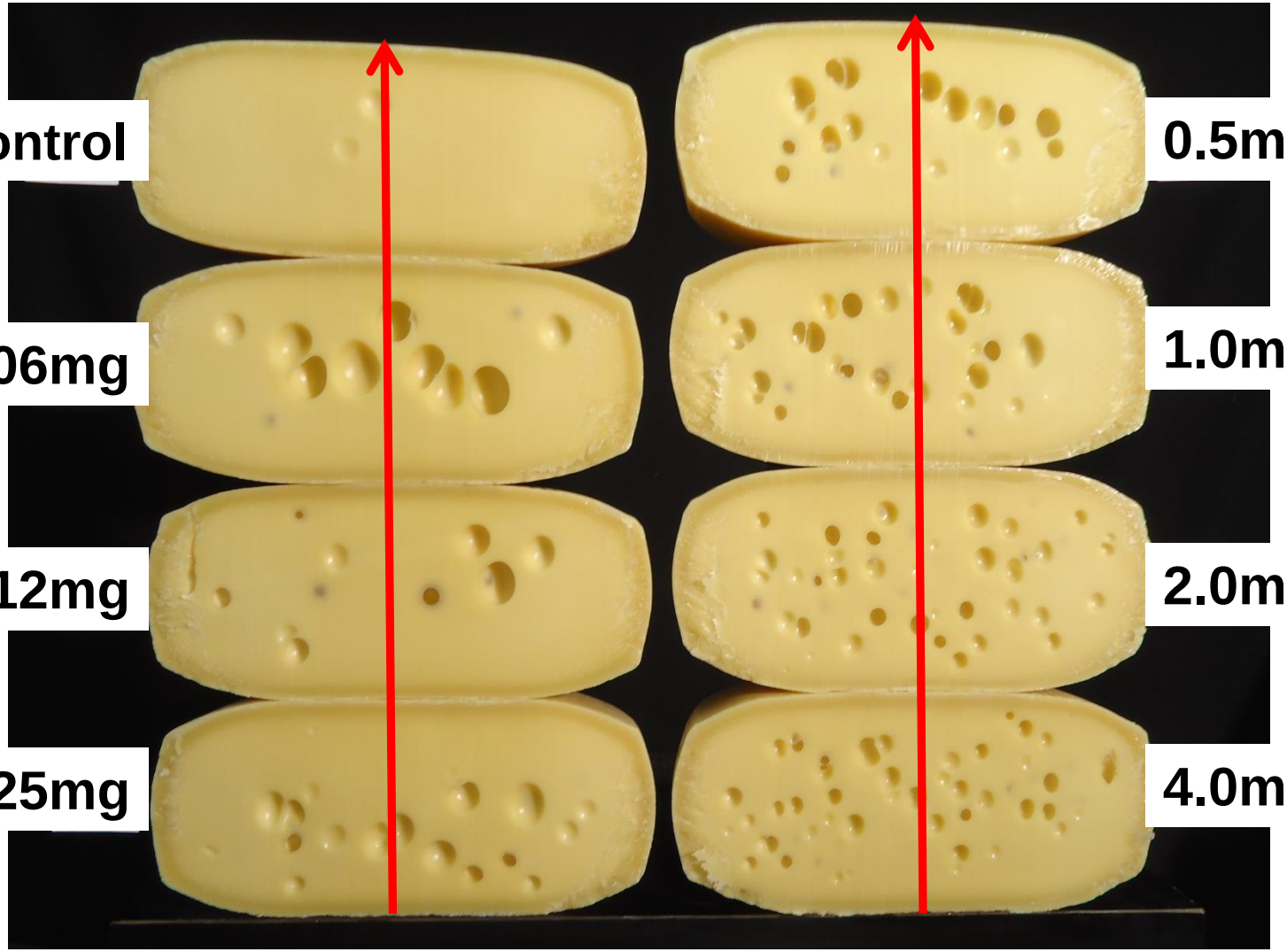
2 mg: 447 eyes



4 mg: 738 eyes

Guggisberg et al., IDJ, 2015

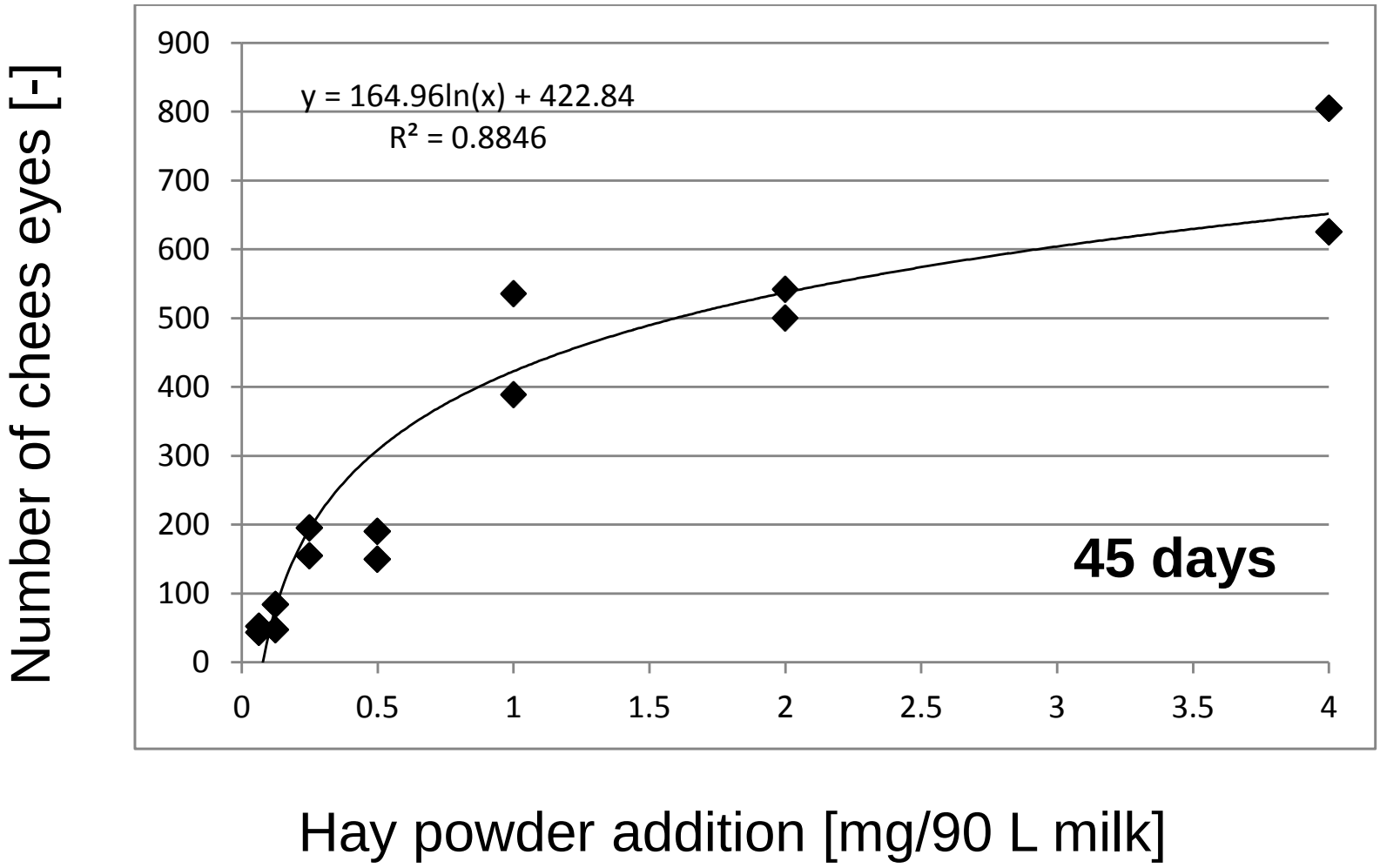
Control of eye formation



Mechanism and control of the eye formation in cheese

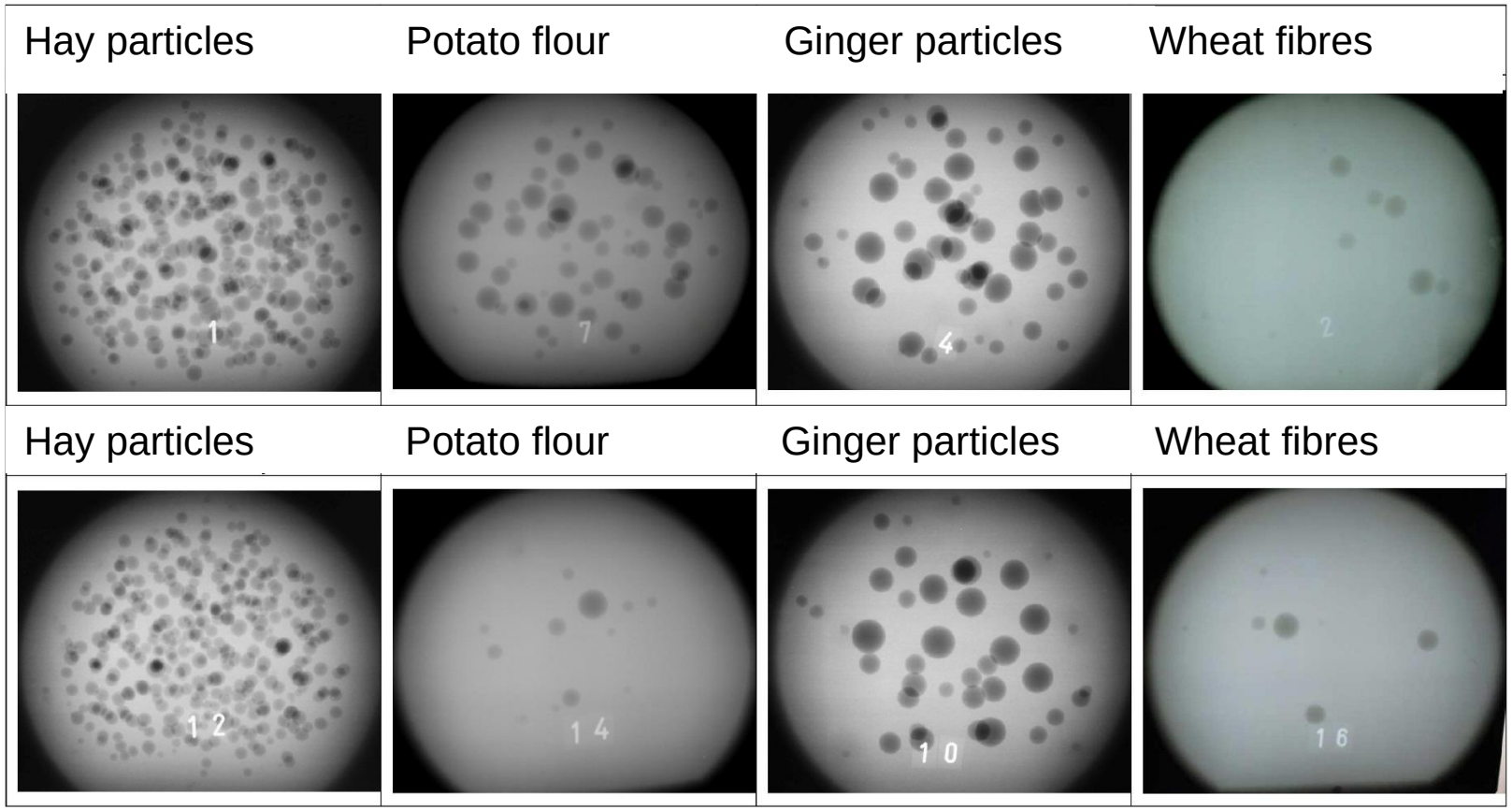
Guggisberg et al., IDJ, 2015

Dose response effect of hay particles



Guggisberg et al., IDJ, 2015

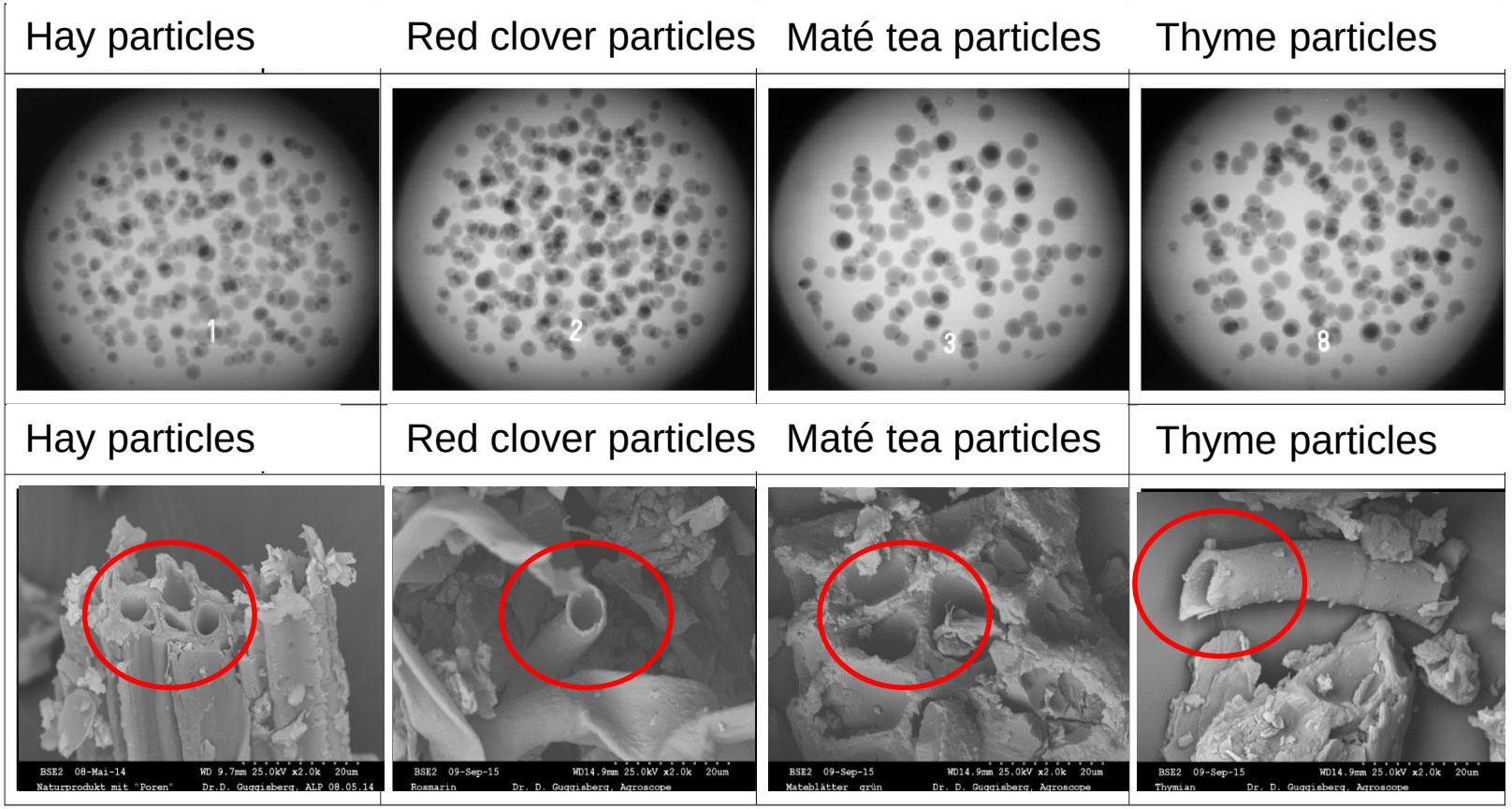
Influence of the botanical origin



→ Vegetable particles from storage tissue are ineffective

→ Processed cellulose- and wheat fibres have no effect

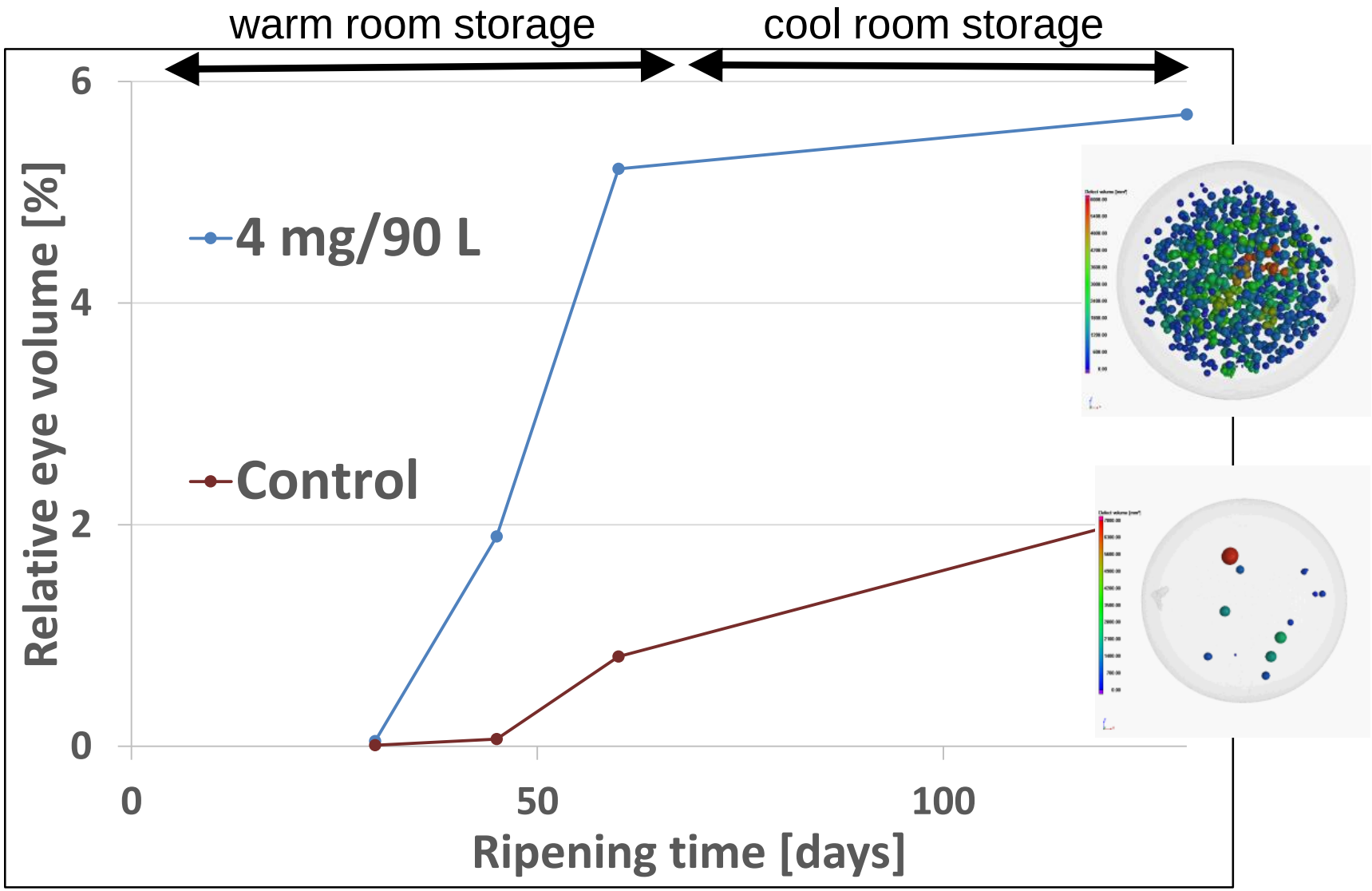
Particles from stems and leaf tissue



→ Very efficient (2 mg / 90 L)

→ reproducible control of eye formation

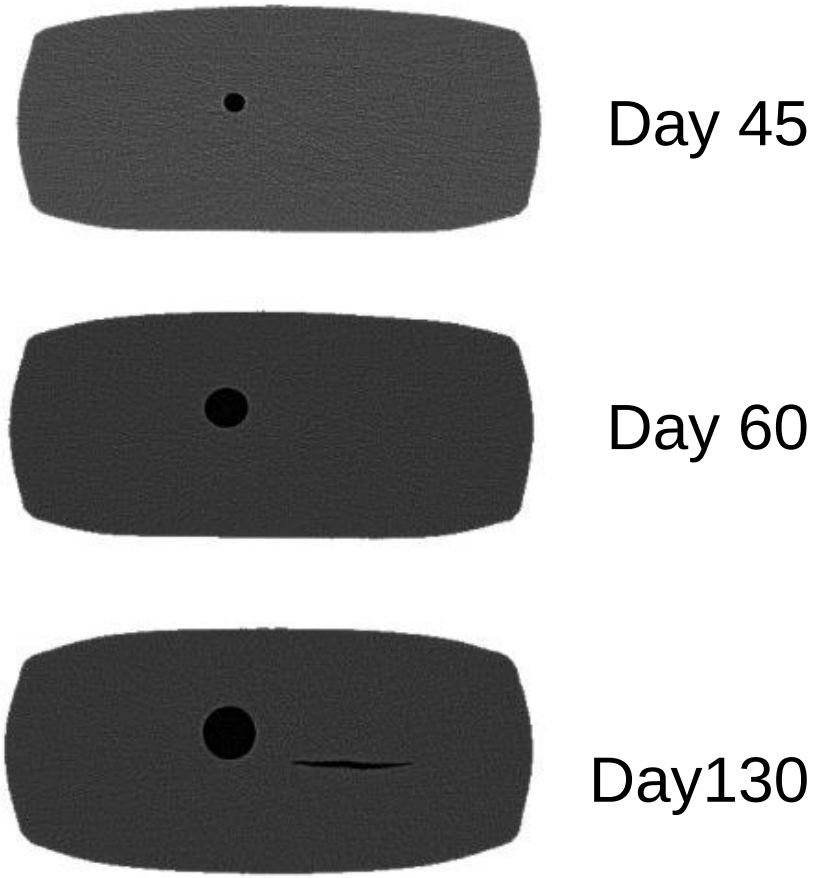
Increase in eye volume during ripening



Mechanism and control of the eye formation in cheese

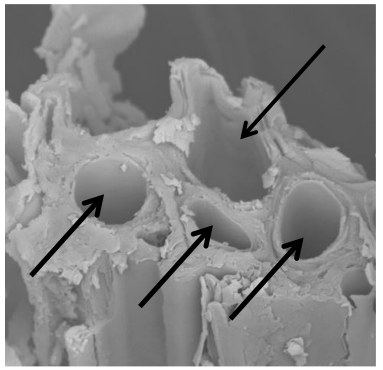
Agroscope

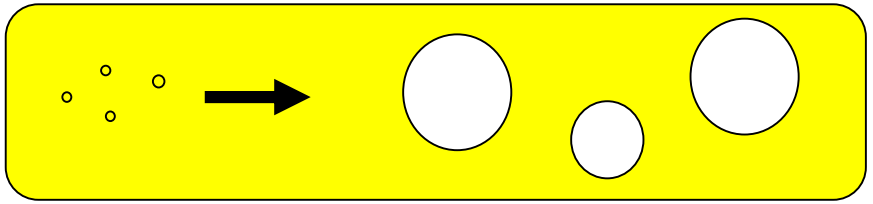
Eye defects: Crack formation



Conclusions

Mechanism of eye formation





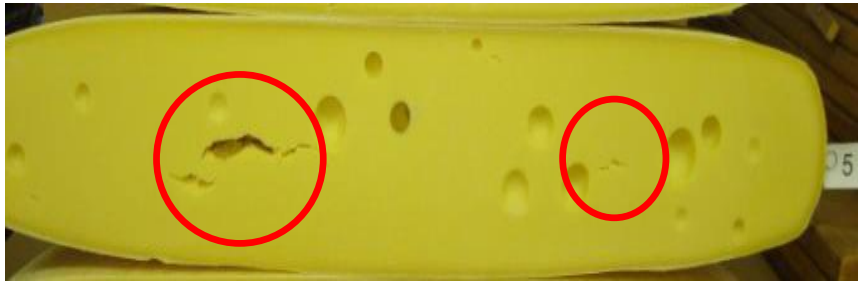
Process control

Number of eyes ✓

Approx. eye volume ✓

Cheese quality ✓

Understanding eye defects



Thanks

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- Florian Loosli

- Thomas Theiler (FOPH)
- Johan Lang (University Bern)
- …

Thank you for your attention