



AN EXPERIMENTAL STUDY OF THE SWELLING BEHAVIOR OF STARCH GRANULES UNDER HEAT TREATMENT

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Gabrielle Moulin, Christophe Doursat, Denis Flick
(contr. FaBE2017-062; book of abstracts: page 65)

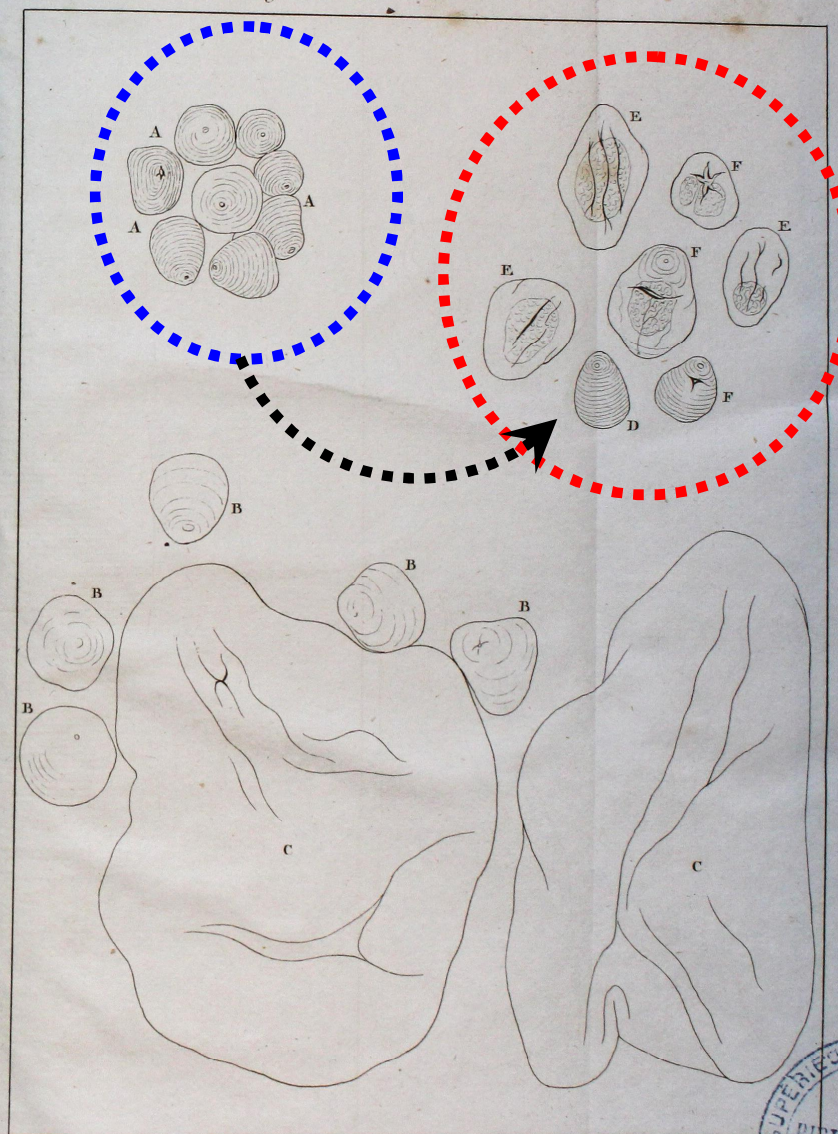
uncooked
starch
granules
in water



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Annales de Chimie et de Phys. Tom. 61.



scope

swollen
starch
granules after
heating
in water



*Payen / Annales de Chimie et
de Physique 61 (1836) 355-374*

□ theories and reviews about starch transformation

- ✓ ...gelatinization & sequence of phase transitions
É e.g. Ratnayake and Jackson (2008)
- ✓ ...retro-gradation (...different meanings)
É e.g. Matignon and Tecante (2017)

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□ swelling of starch suspensions under heat treatment

- ✓ ...rheological behavior of many food products
- ✓ ...difficult subject: transient phenomena

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❑ swelling of starch suspensions under heat treatment

- ✓ ...rheological behavior of many food products
- ✓ ...challenging subject: transient phenomena

❑ in this study:

- ✓ diversity of granules size along their thermal history
- ✓ diversity of temperatures at the swelling onset

- ☐ scope 
- ☐ methods
- ☐ diversity of thermal histories
- ☐ swelling onset and initial granule size
- ☐ influence of granule orientation (...?)
- ☐ summary and future work

□ hot-stage
microscopy

Olympus BX-51
microscope



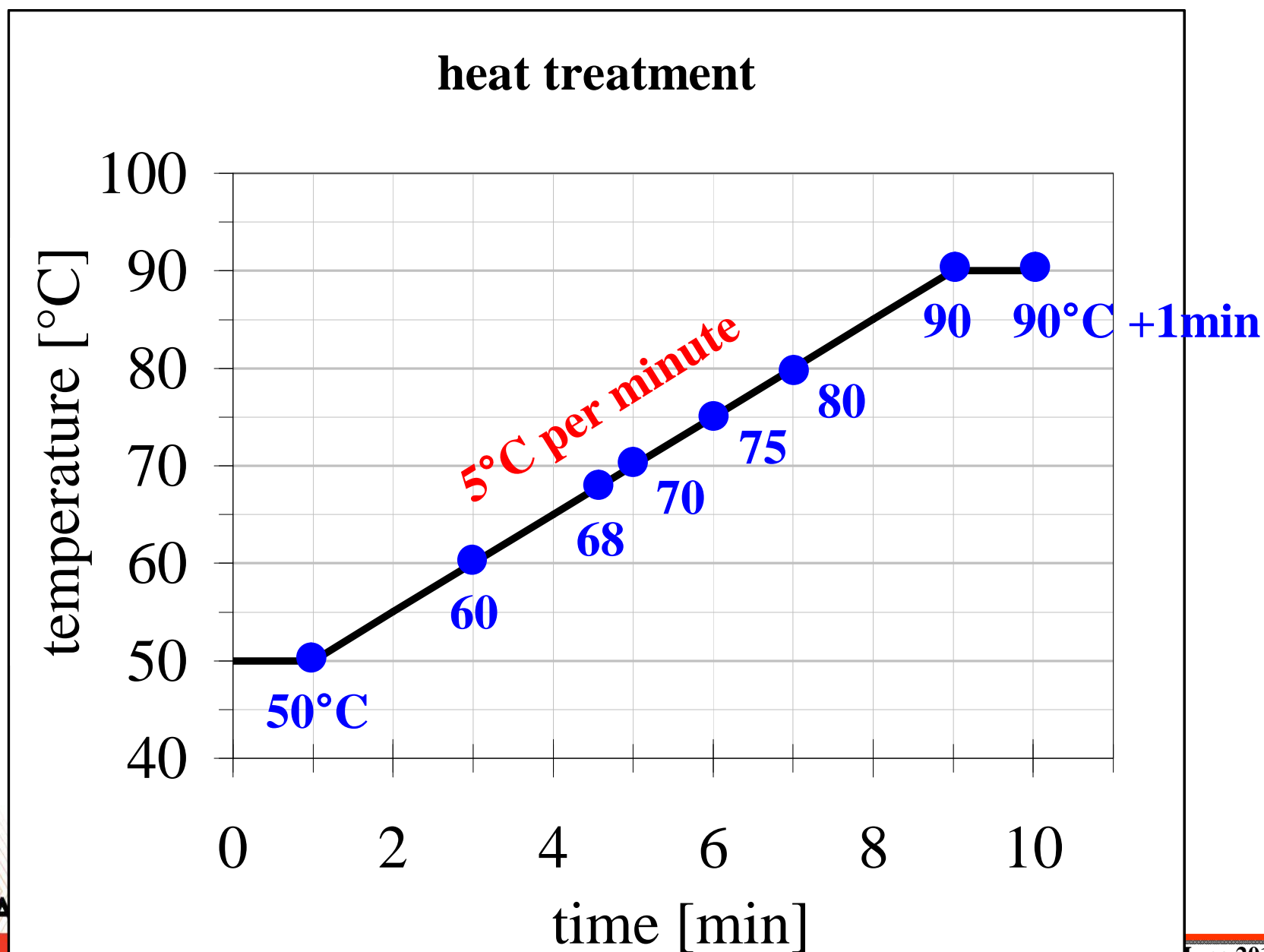
Basler A102fc
digital camera

0.5 mL of
modified waxy maize
starch suspension
(5 g/kg)

50X



Linkam LTS120 stage



heat treatment

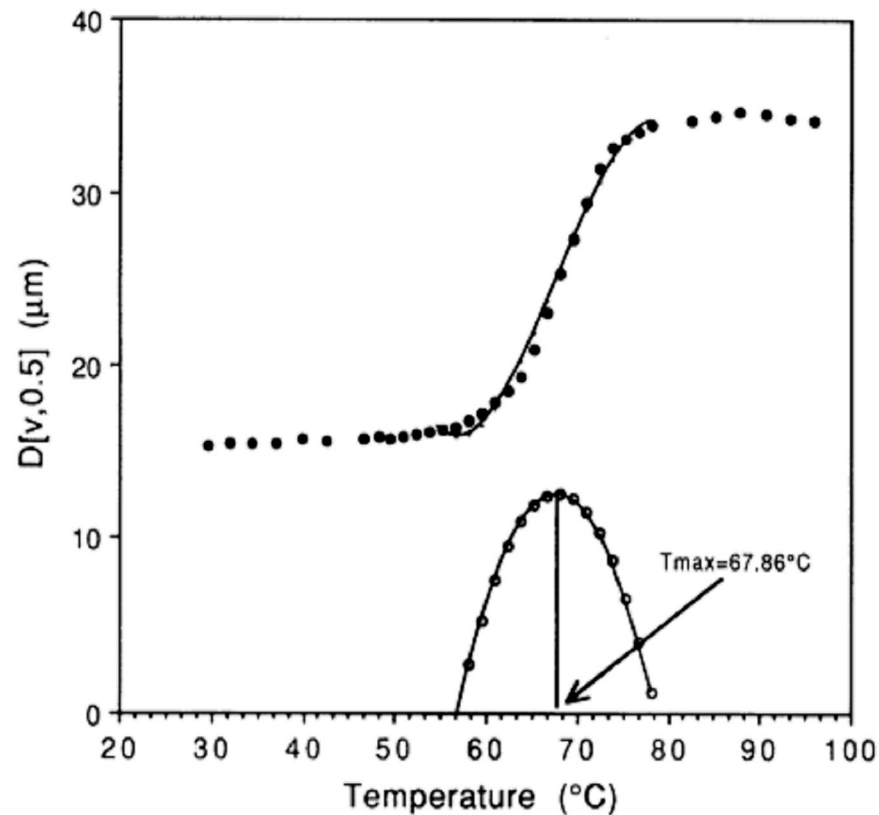
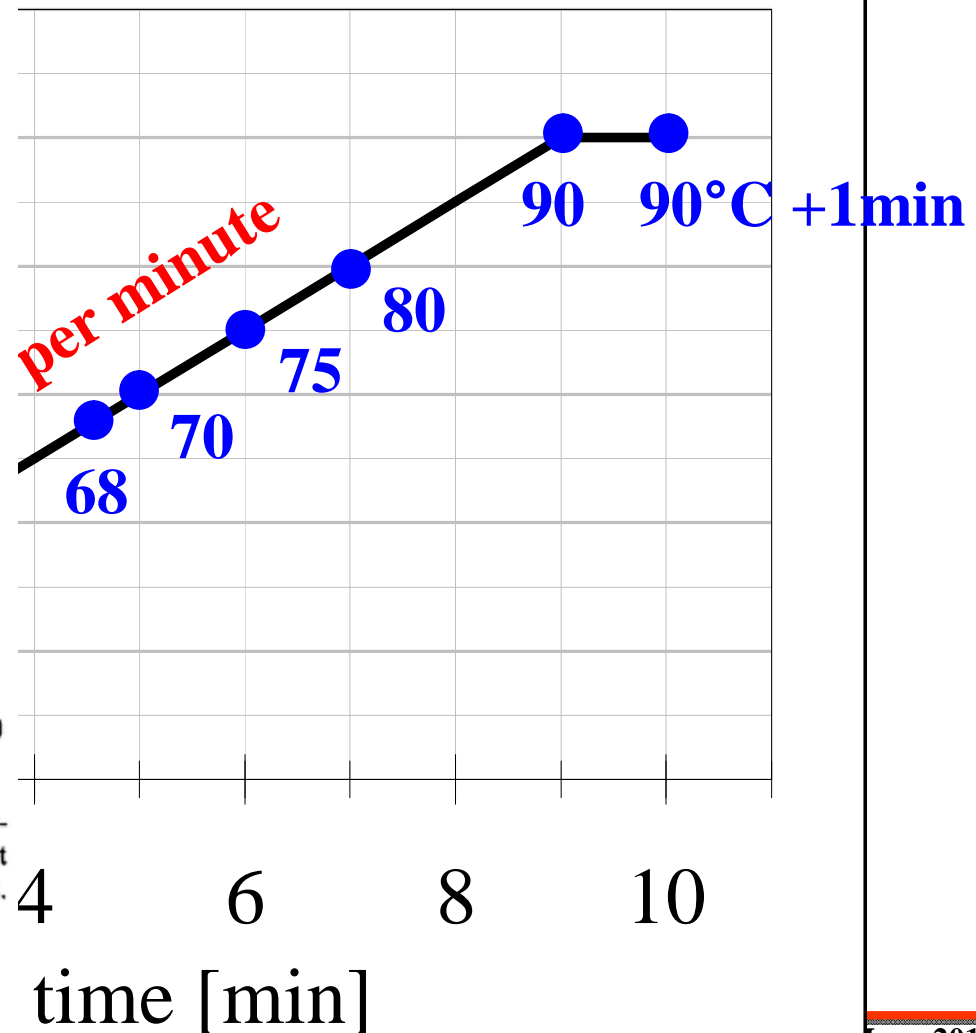
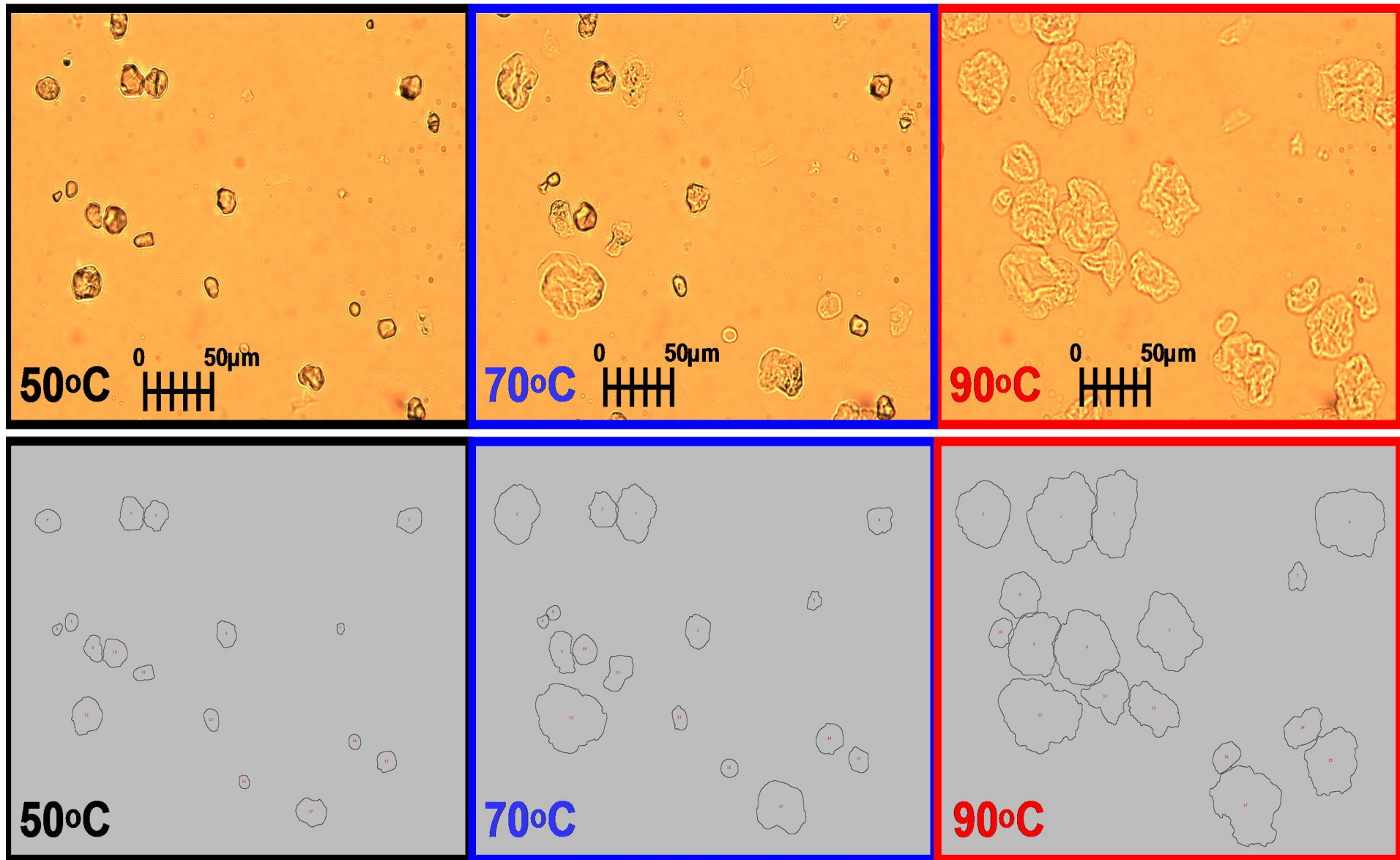


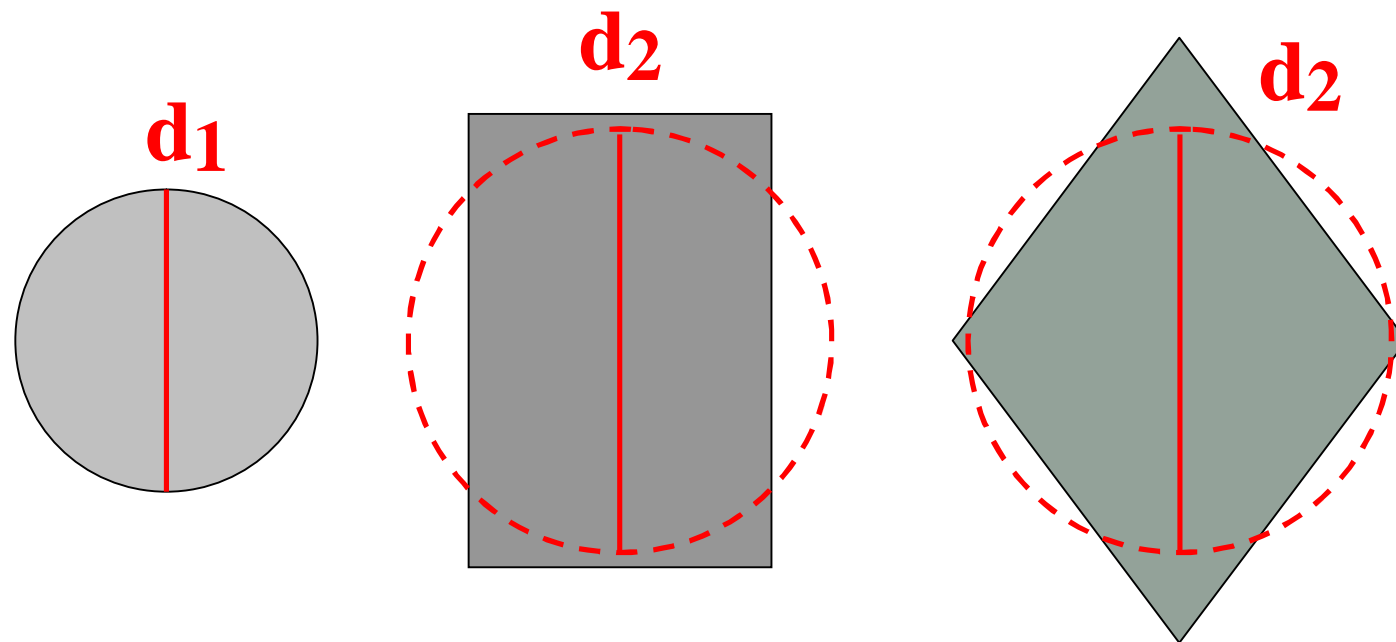
Fig. 4. Determination of T_{\max} for starch swelling from diameter-temperature data (●) for a sample of common corn starch heated at $4.8^{\circ}\text{C}/\text{min}$. R^2 for the 3rd order polynomial regression of $D[v,0.5]$ vs. temperature was 0.993. ○ = 1st derivative of the polynomial.



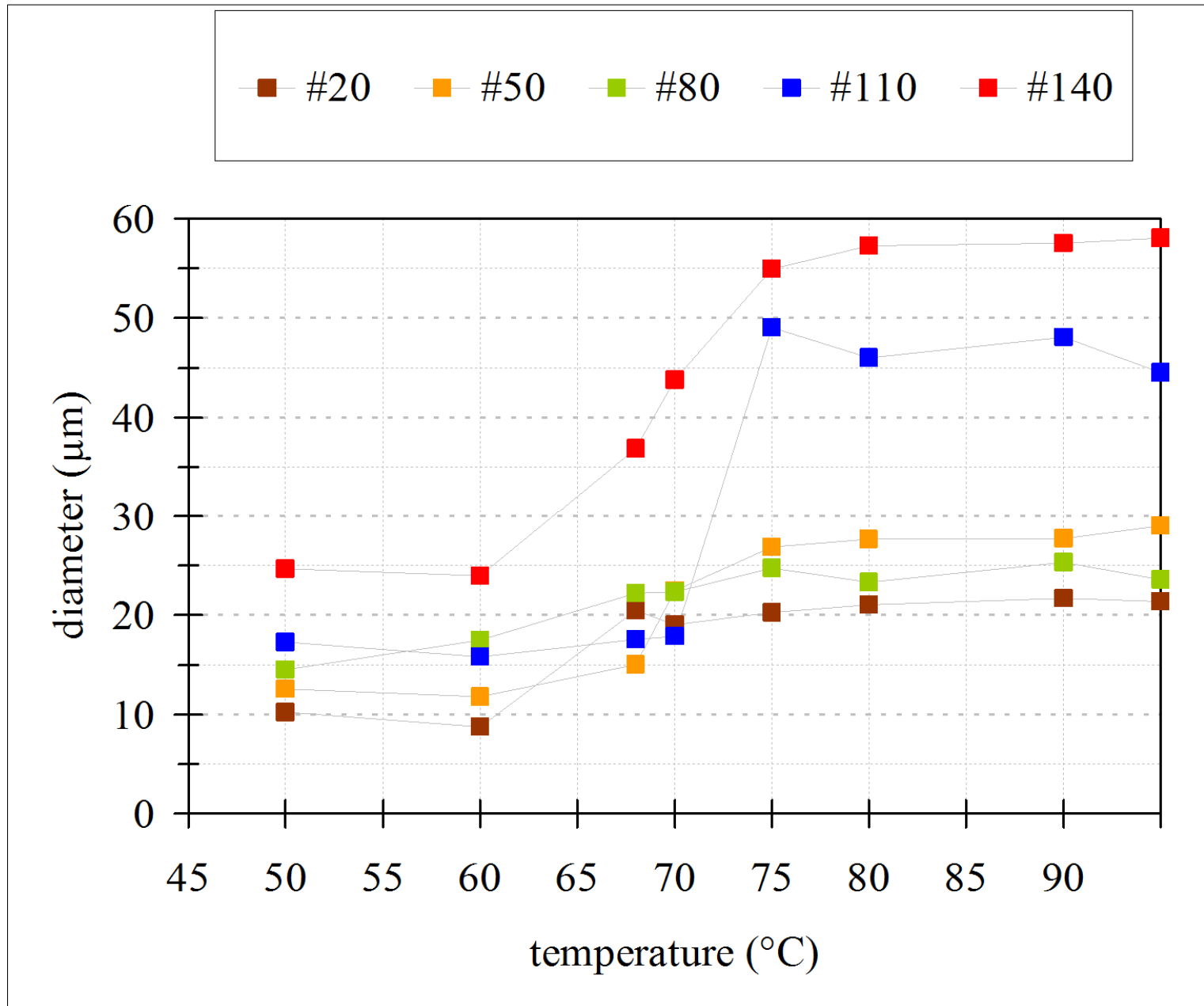


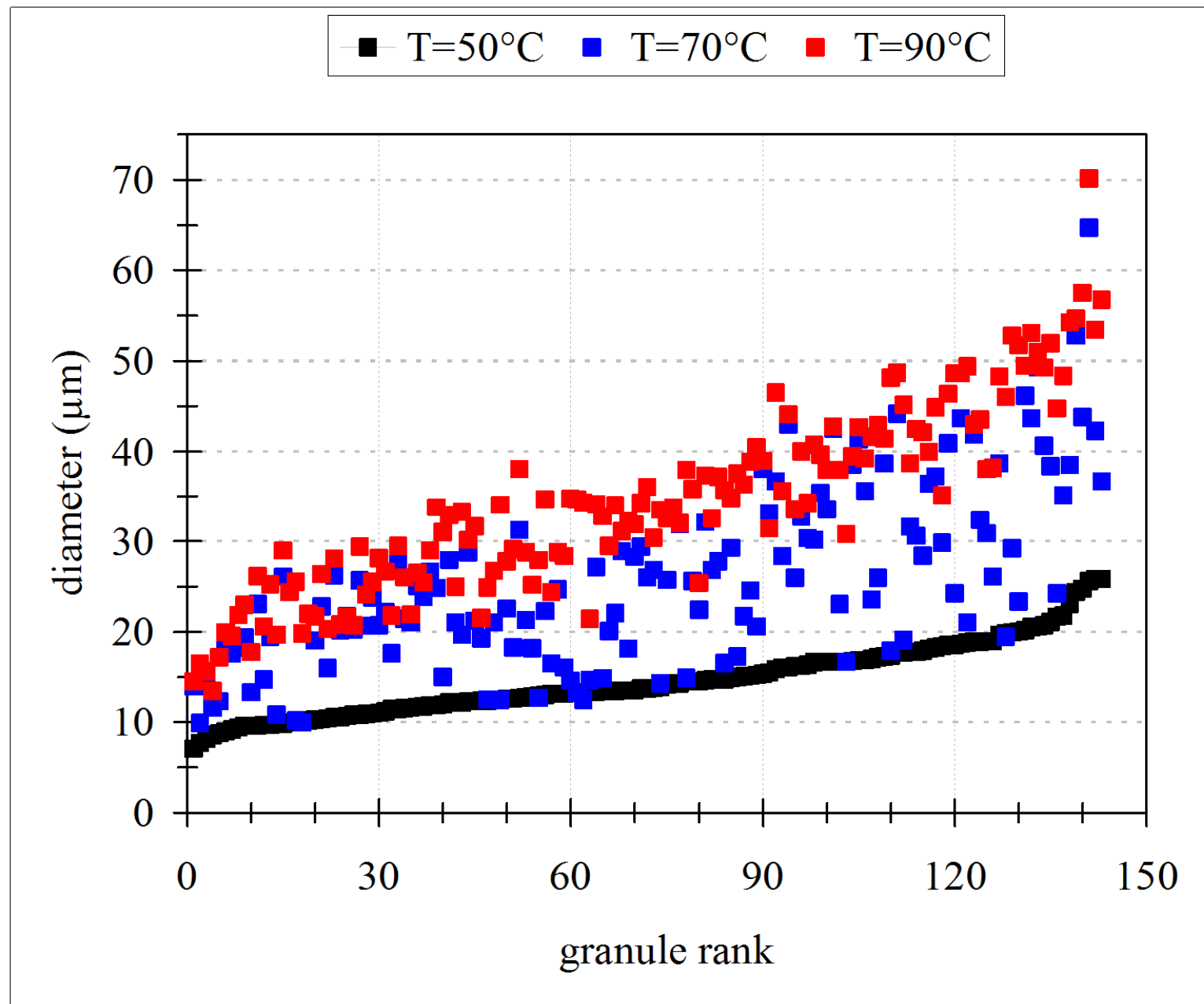
□ measure of starch granule (apparent) "size"

- ✓ software Image-J estimates the granule mean diameter from its apparent surface

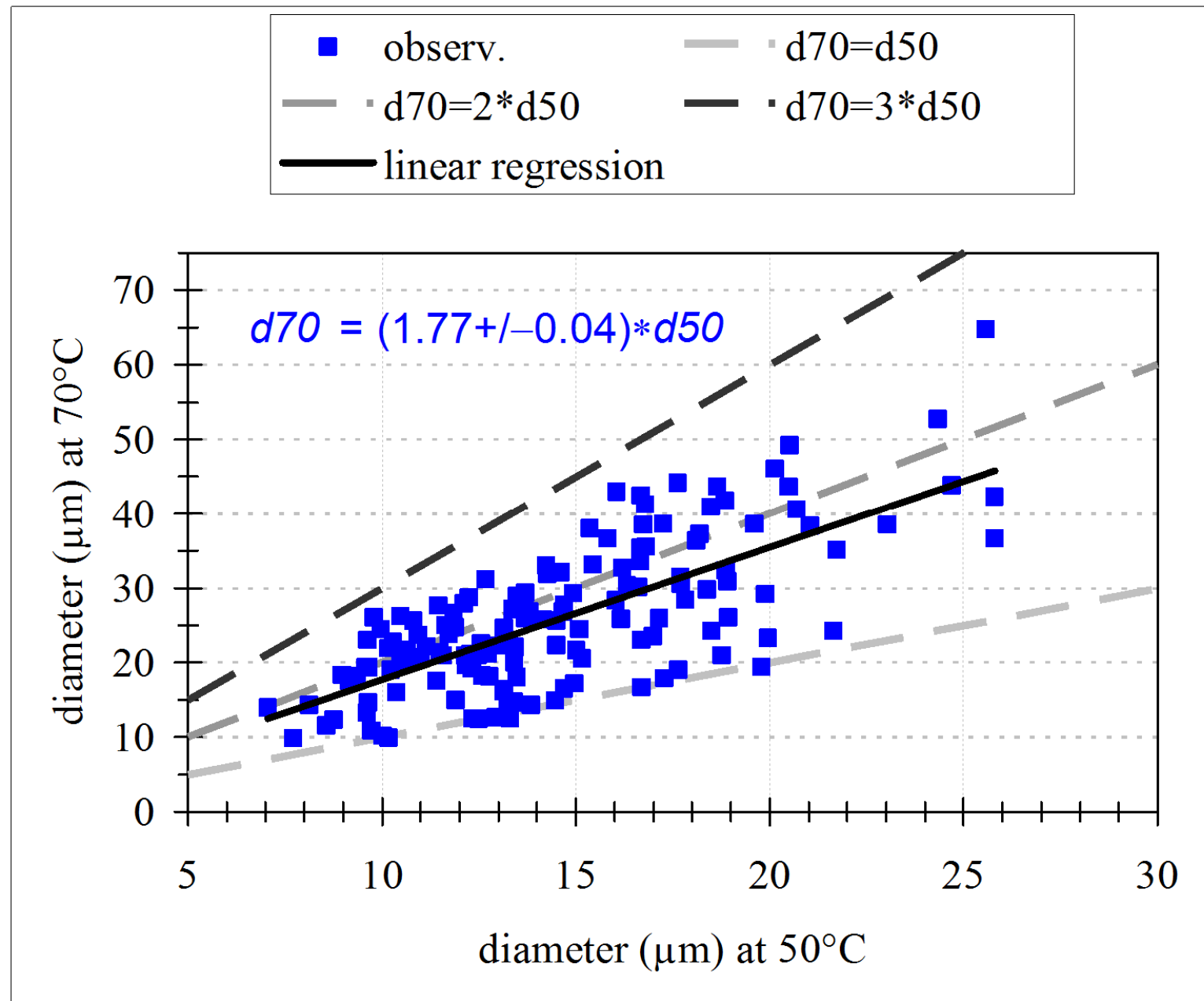


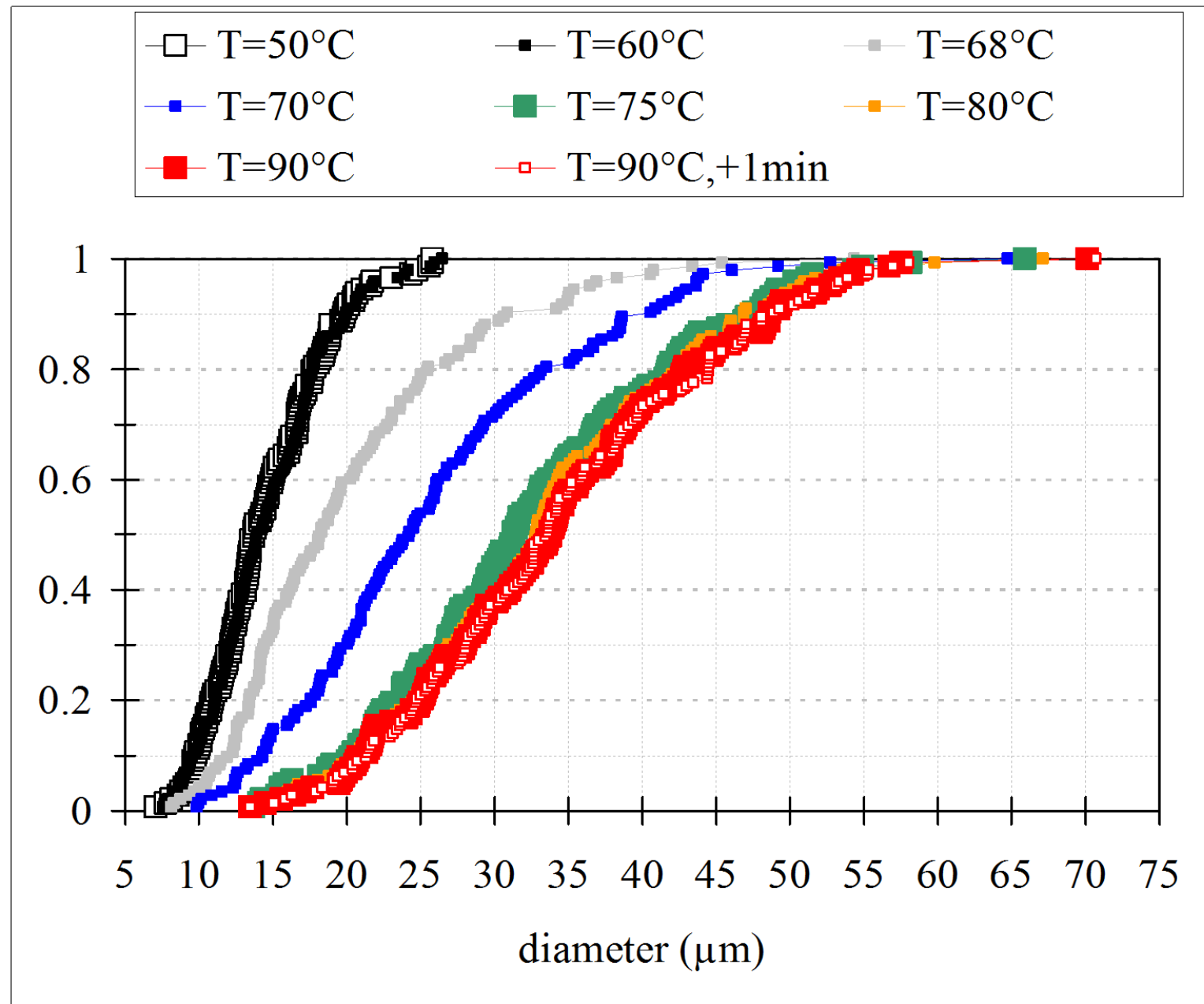
diversity of thermal histories

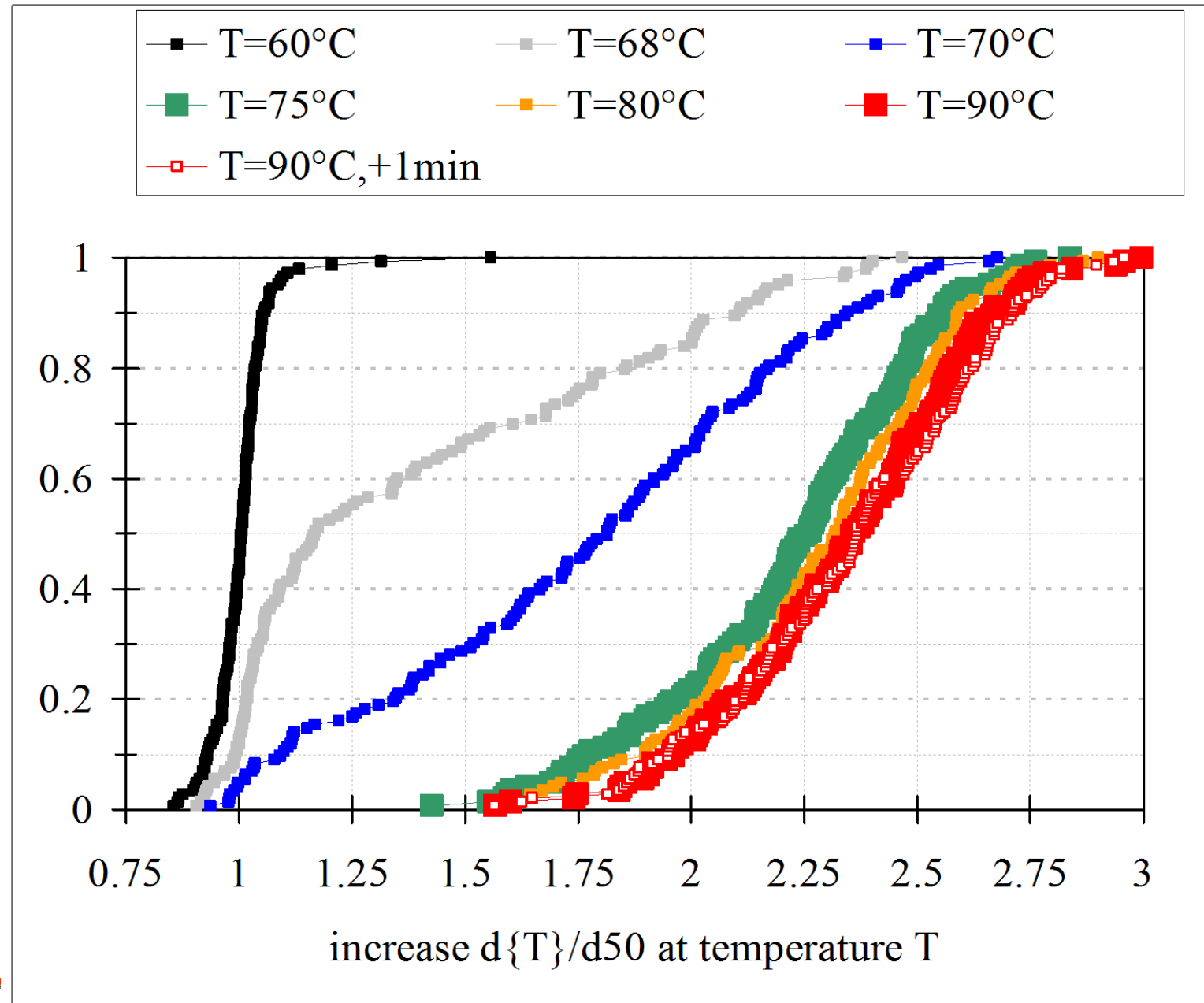




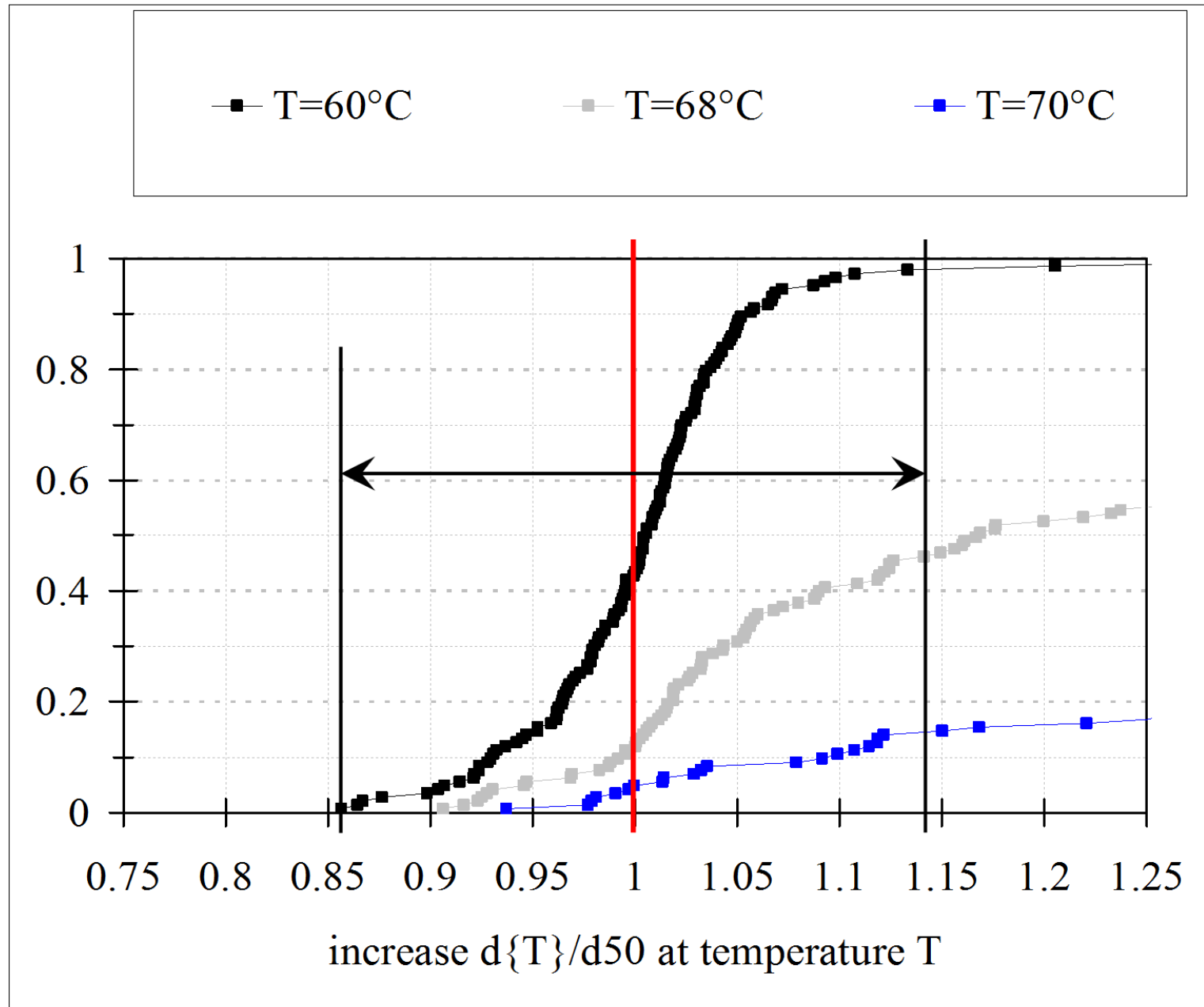
swelling onset and initial granule size



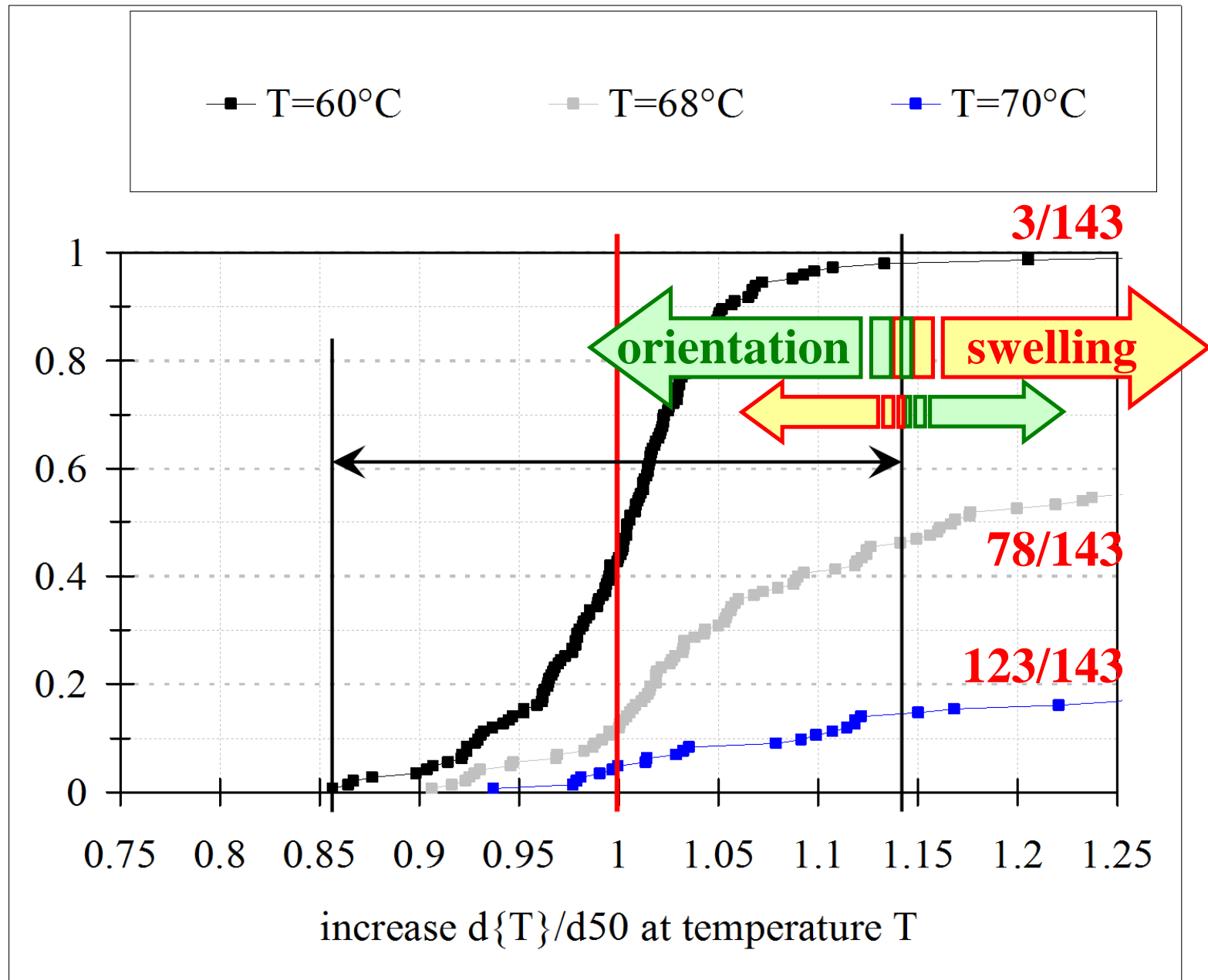


swelling and granule size increase

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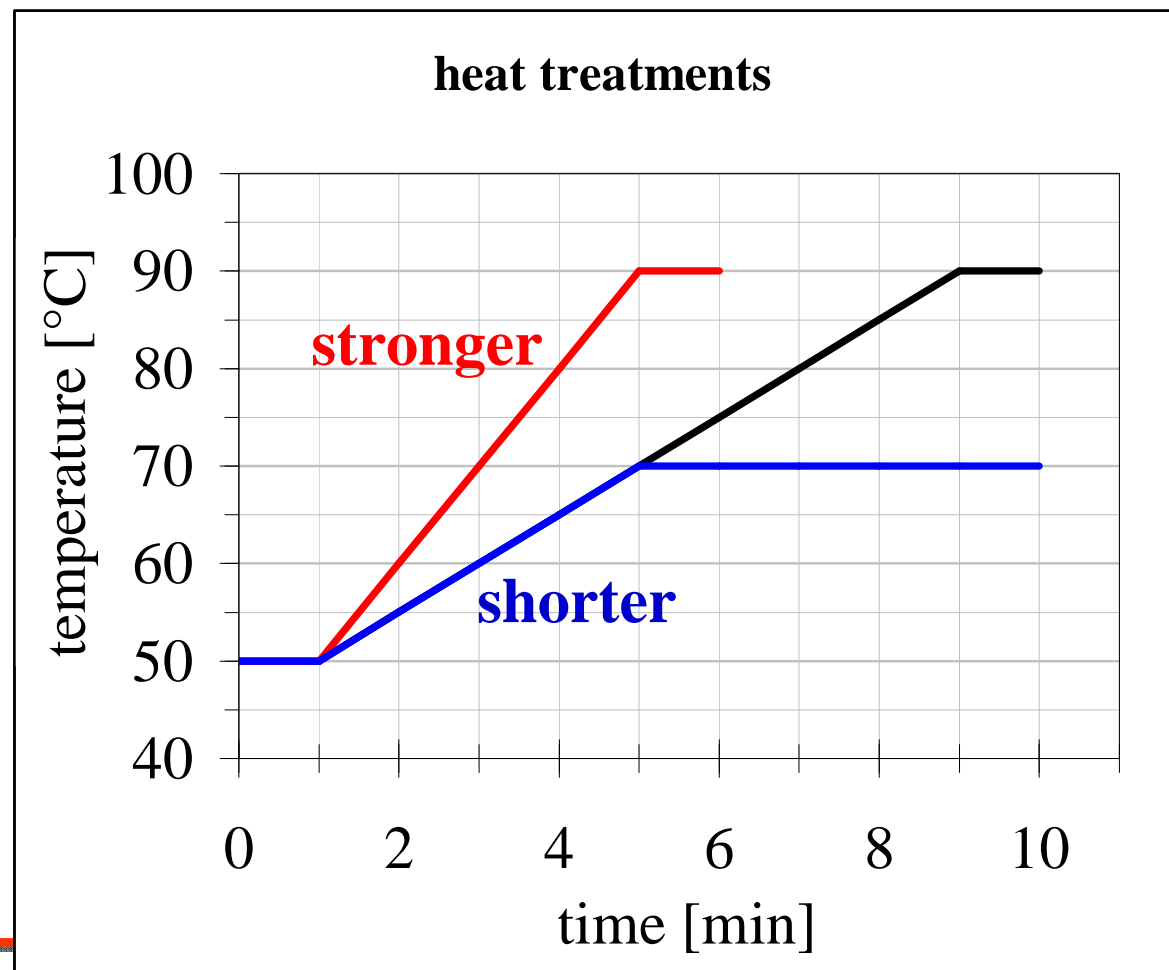
influence of granule orientation (...!!!)



- ❑ summary:
- ❑ changes in the starch swelling state were relatively weak below 60 °C and above 80 °C (as expected)
- ❑ occurrence of uncooked and swollen granules at intermediate temperatures, simultaneously
- ❑ no relationship was found between initial granule diameter and swelling onset temperature

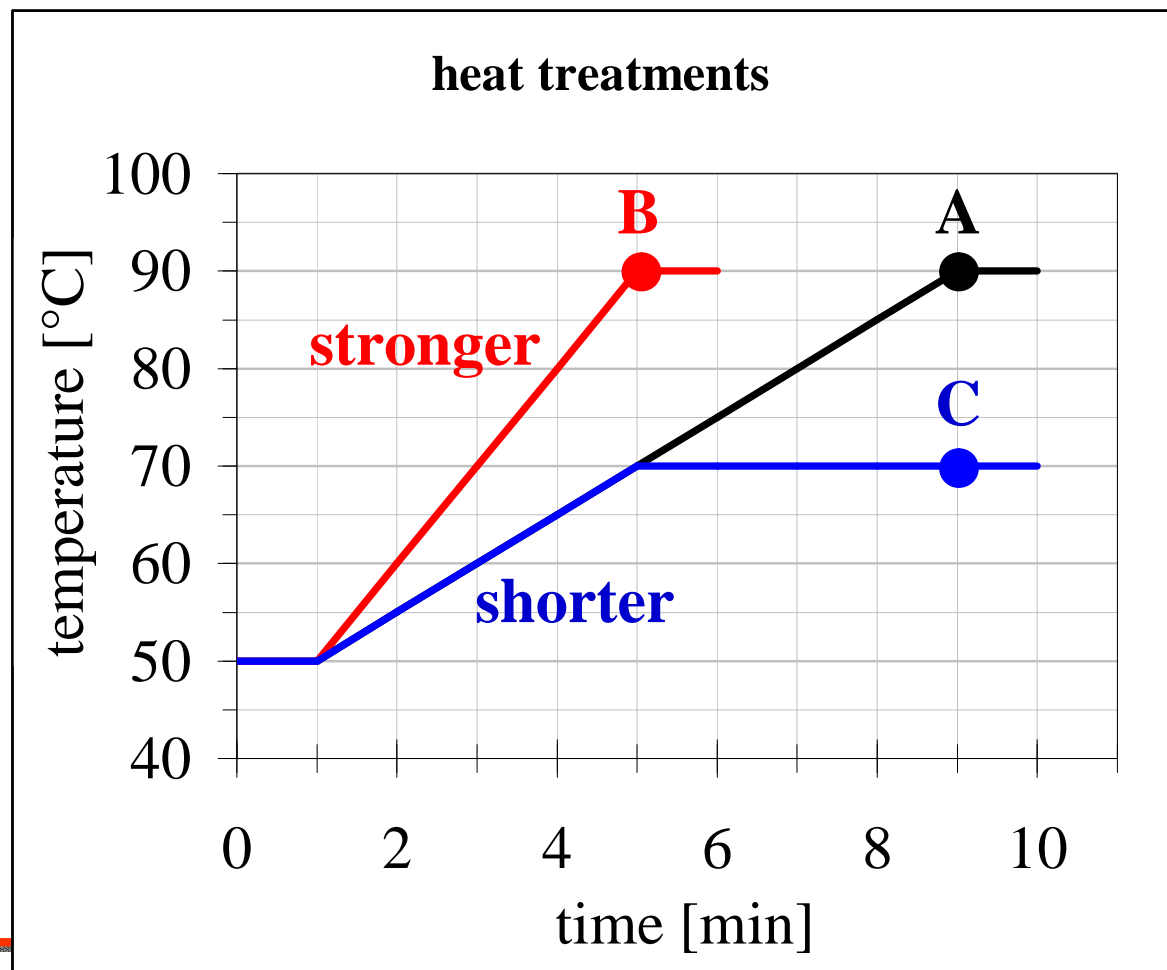
□ future work:

- ✓ to assess the influence of heating rate and duration



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- ✓ to assess the influence of heating rate and duration
- ✓ to model the influence of granule orientation on observations

