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► To cite this version:

Artemio Plana-Fattori, Giana Almeida, Gabrielle Moulin, Christophe Doursat, Denis Flick. An experimental study of the swelling behavior of starch granules under heat treatment. 3. International Conference on Food and Biosystems Engineering (I. C. FaBE 2017), Laboratory of Food & Biosystems Engineering (FABE Lab)., Jun 2017, Rhodes, Greece. 562 p. hal-02738099

HAL Id: hal-02738099

<https://hal.inrae.fr/hal-02738099>

Submitted on 23 Aug 2023

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

Artemio Plana-Fattori, Giana Almeida-Perré,
Gabrielle Moulin, Christophe Doursat, Denis Flick
(contr. FaBE2017-062; book of abstracts: page 65)

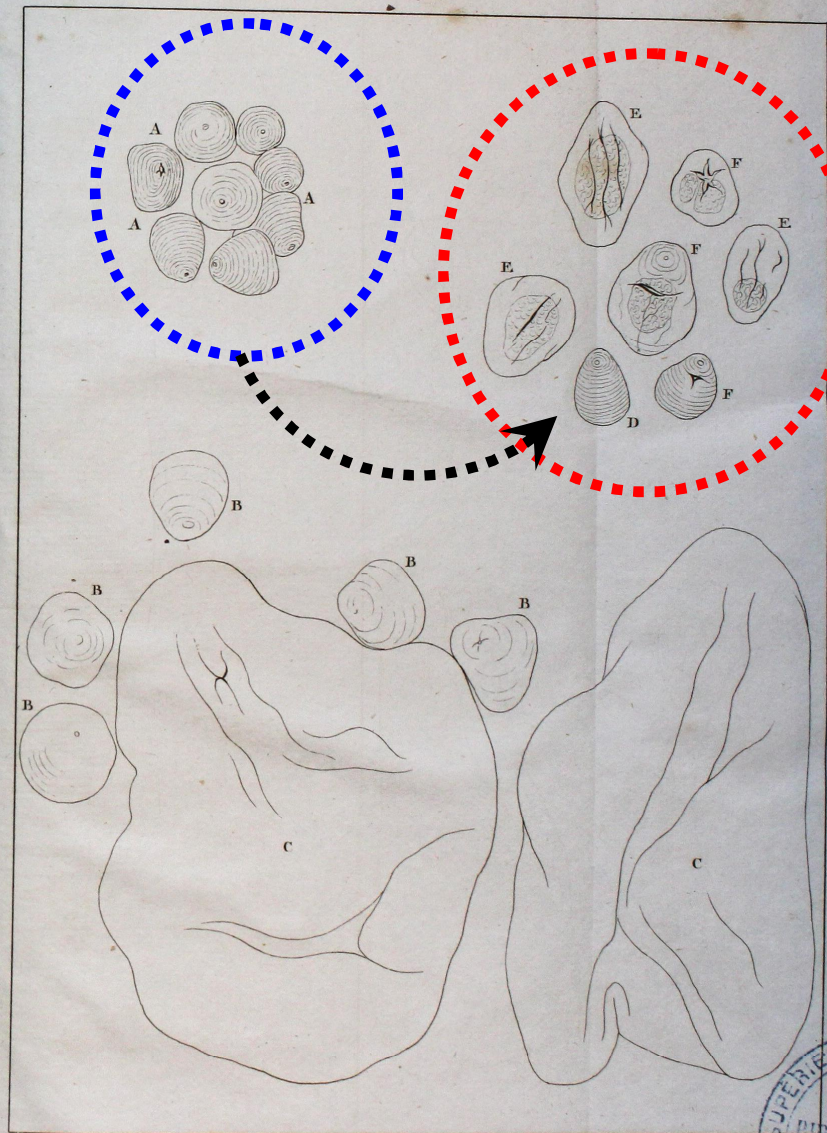
uncooked
starch
granules
in water



AgroParisTech

UMR
1145
GENIAL

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

❑ theories and reviews about starch transformation


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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



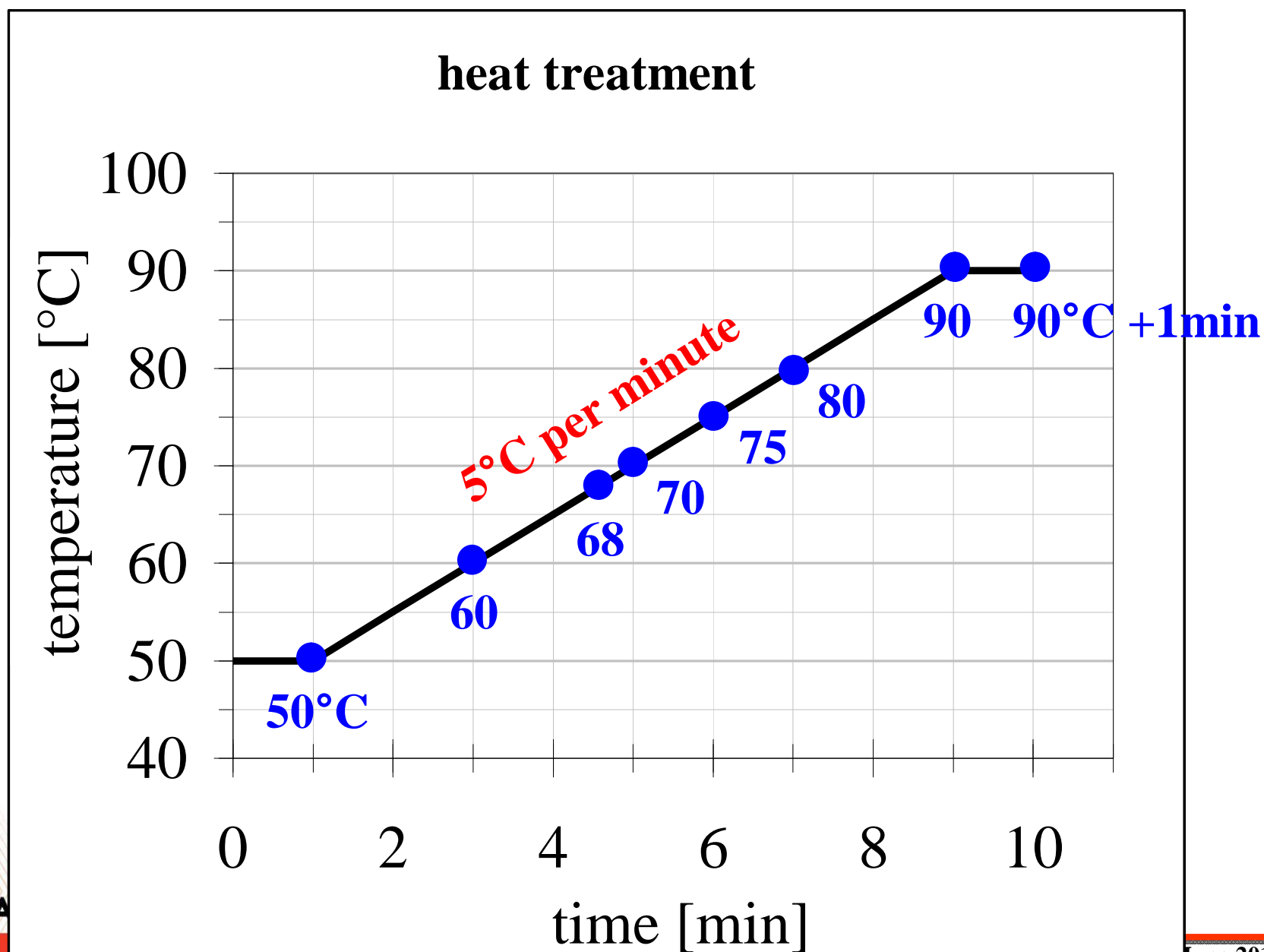
Basler A102fc
digital camera

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

50X



Linkam LTS120 stage



heat treatment

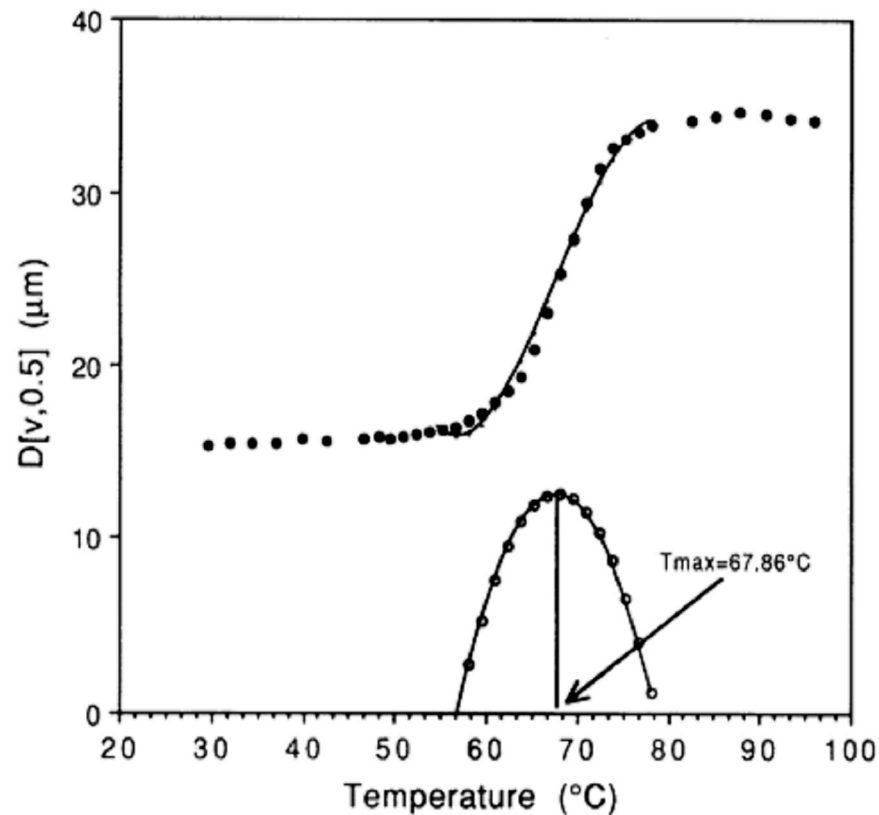
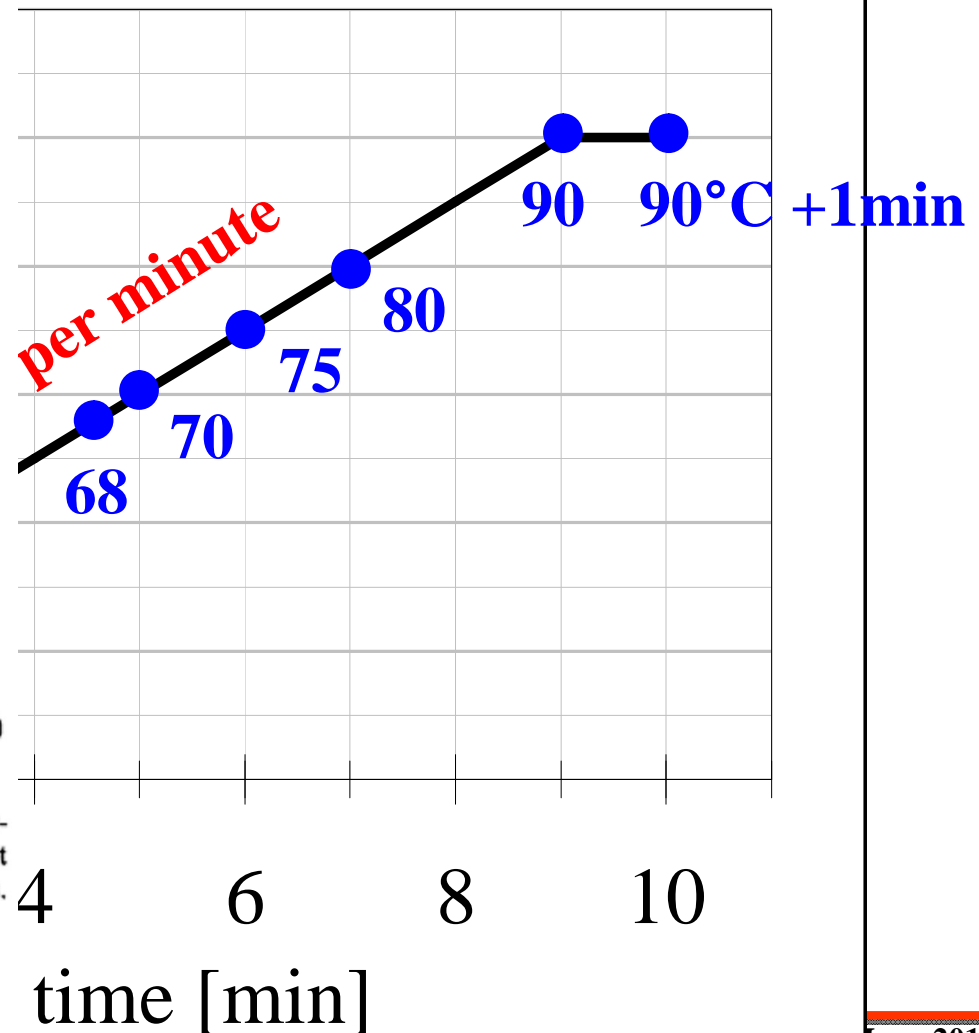
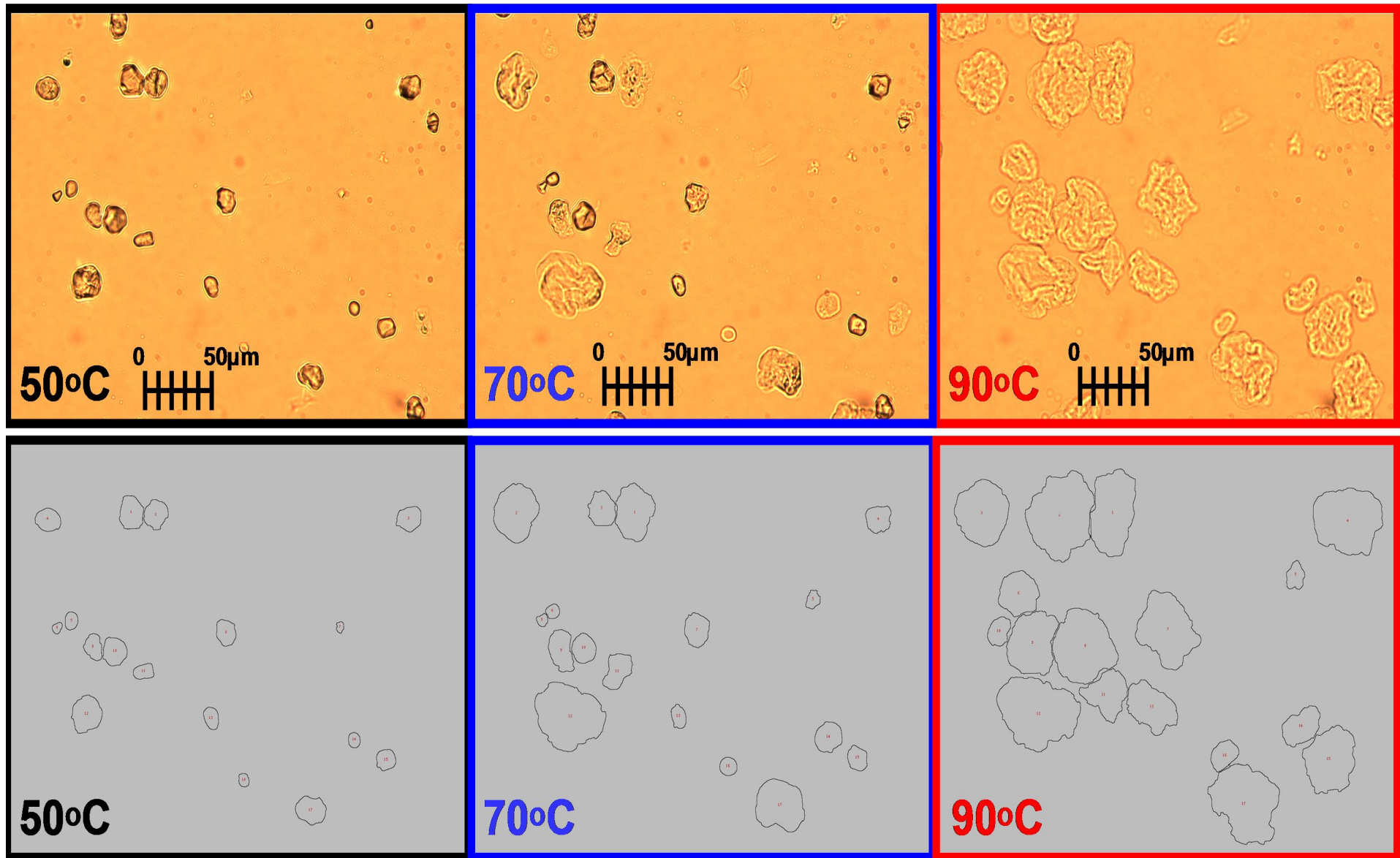


Fig. 4. Determination of T_{max} for starch swelling from diameter-temperature data (●) for a sample of common corn starch heated at $4.8^{\circ}\text{C}/\text{min}$. R^2 for the 3rd order polynomial regression of $D[v,0.5]$ vs. temperature was 0.993. ○ = 1st derivative of the polynomial.

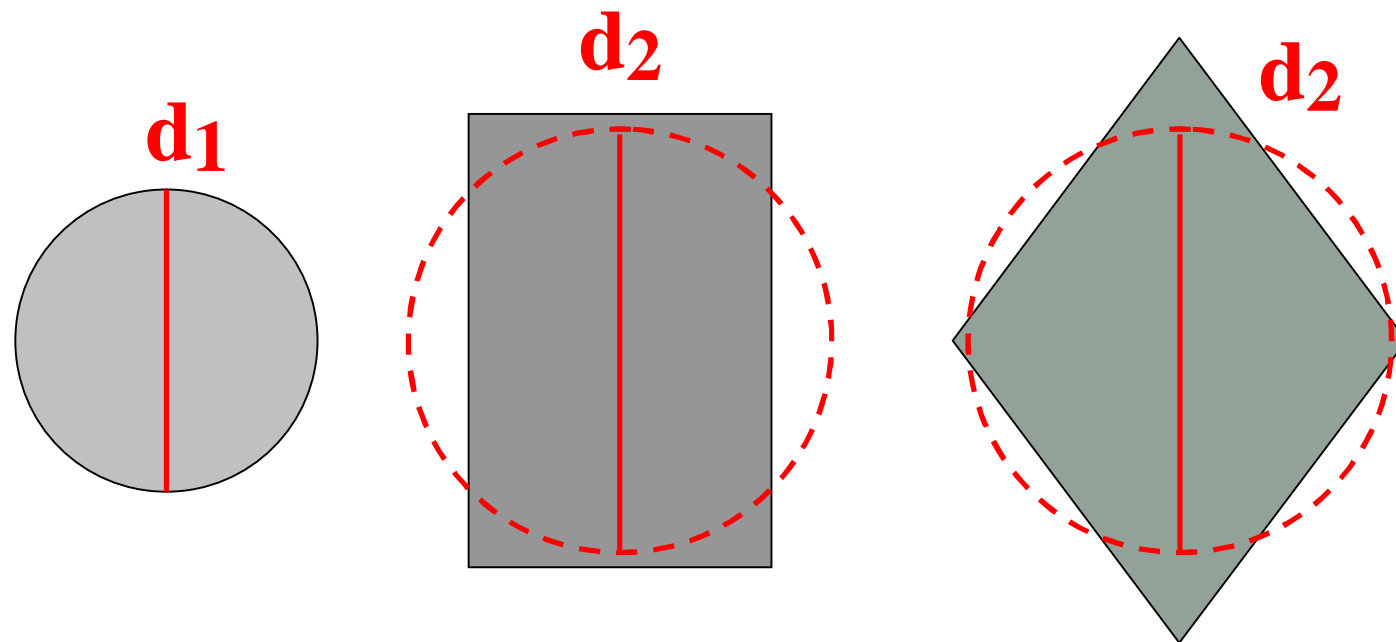
Ziegler et al. (1993)



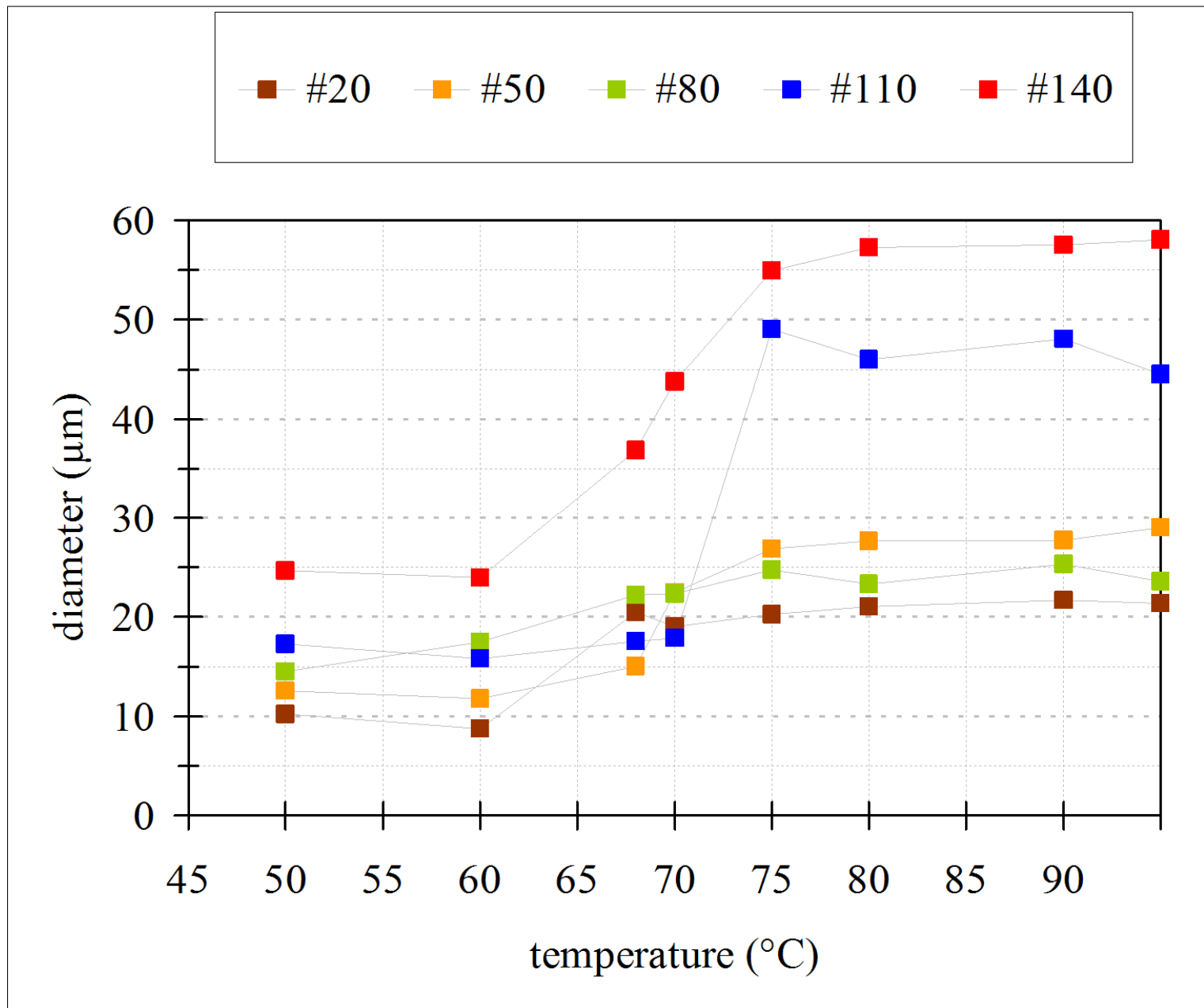


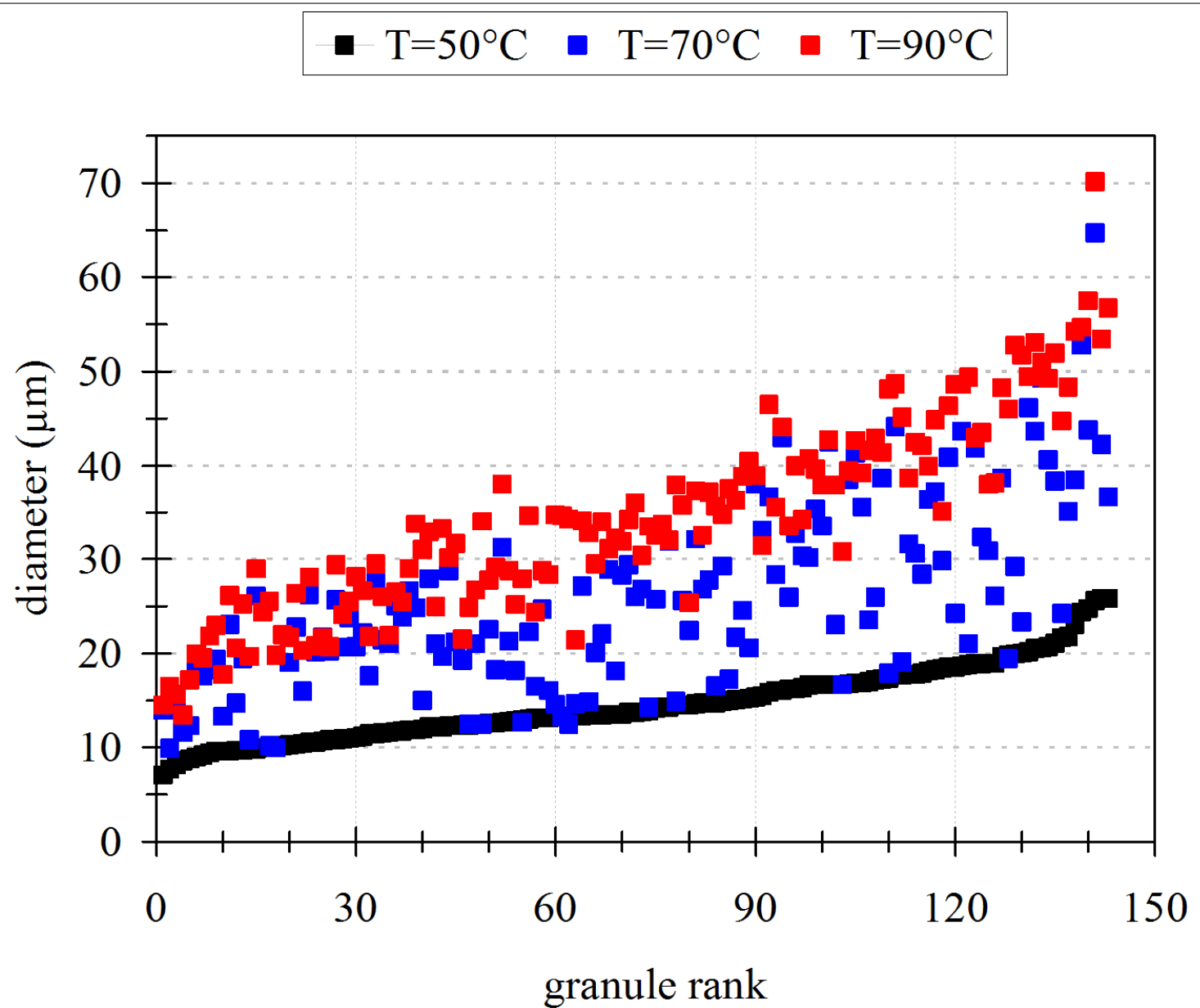
□ measure of starch granule (apparent) "size"

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

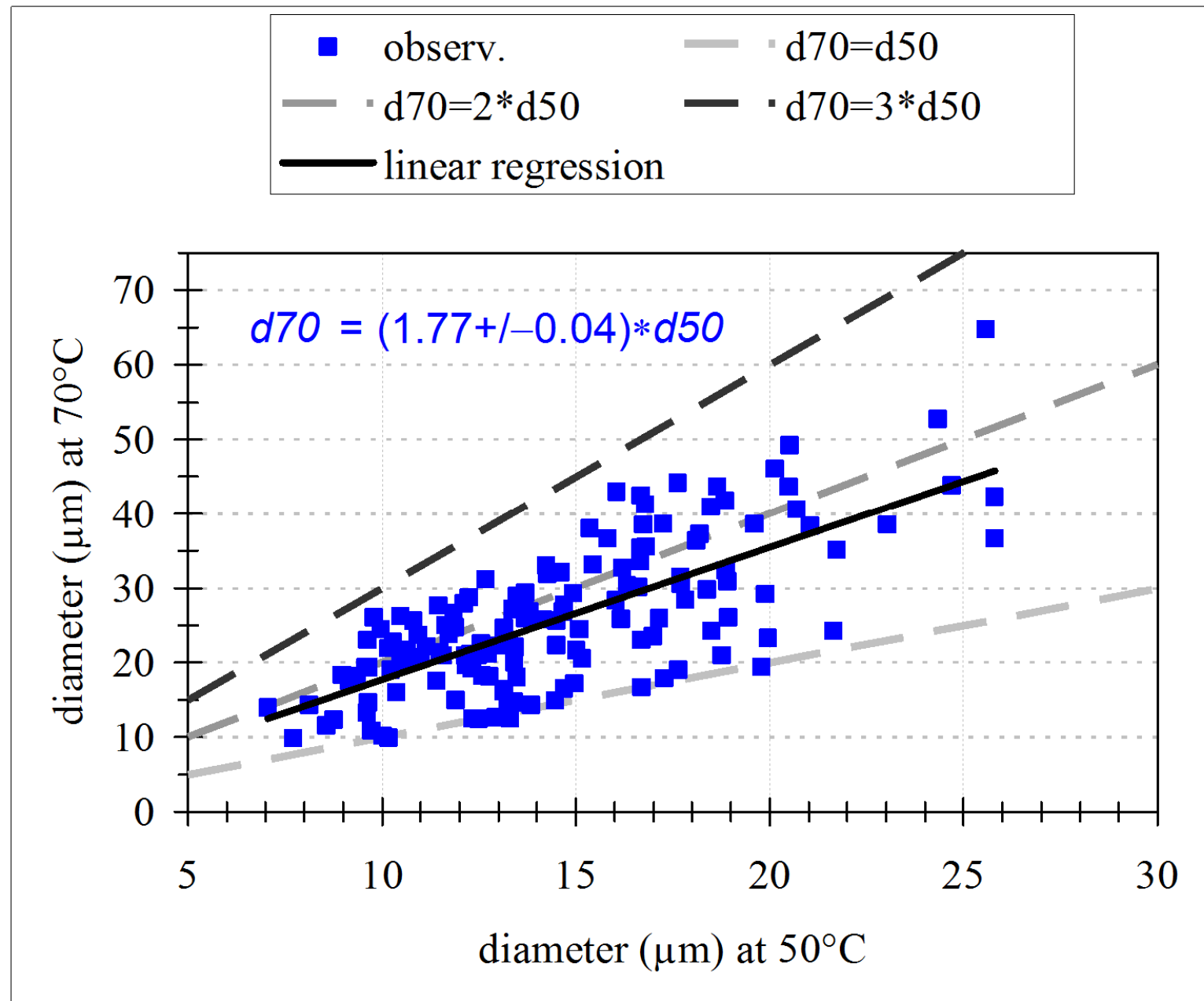


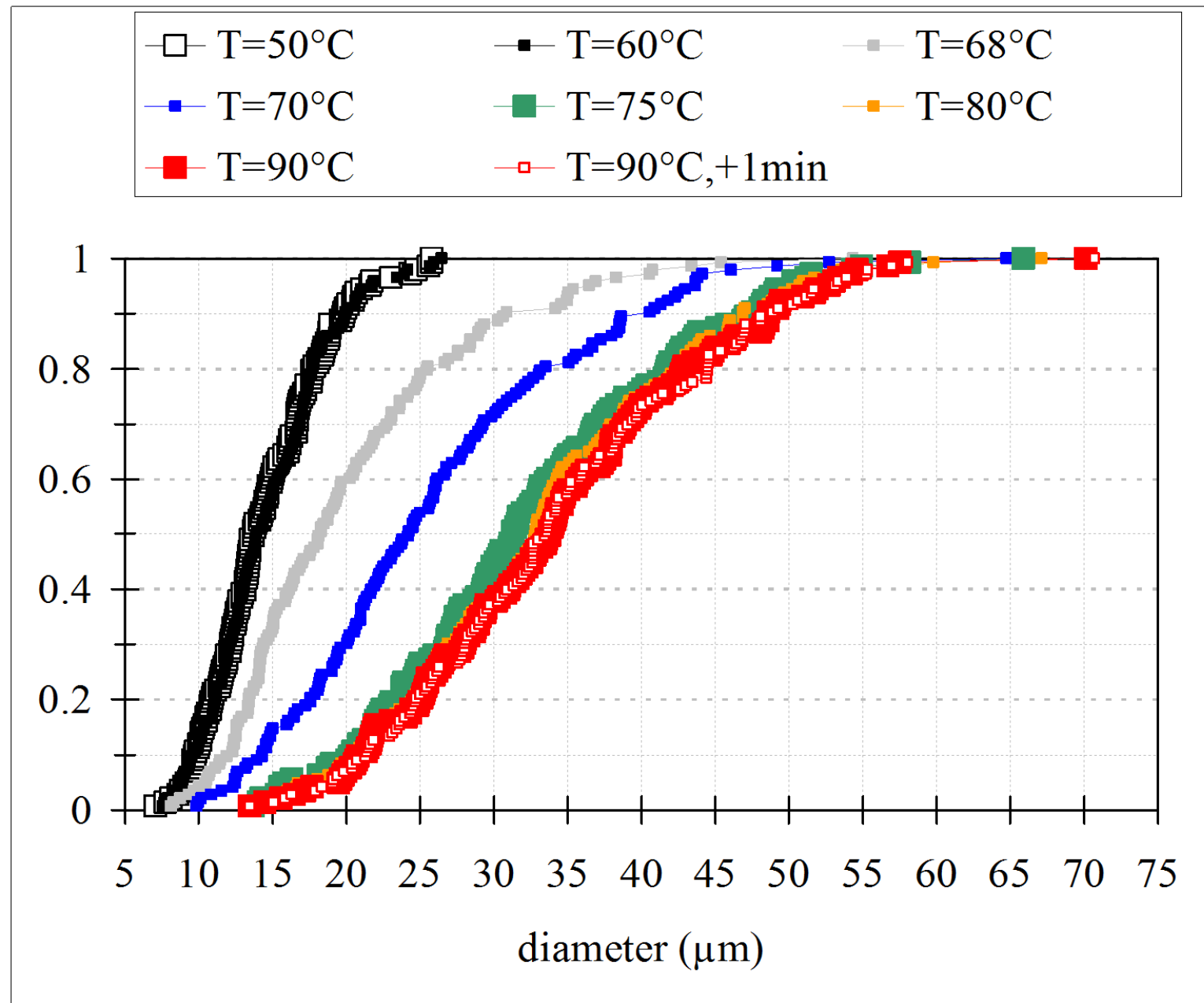
diversity of thermal histories

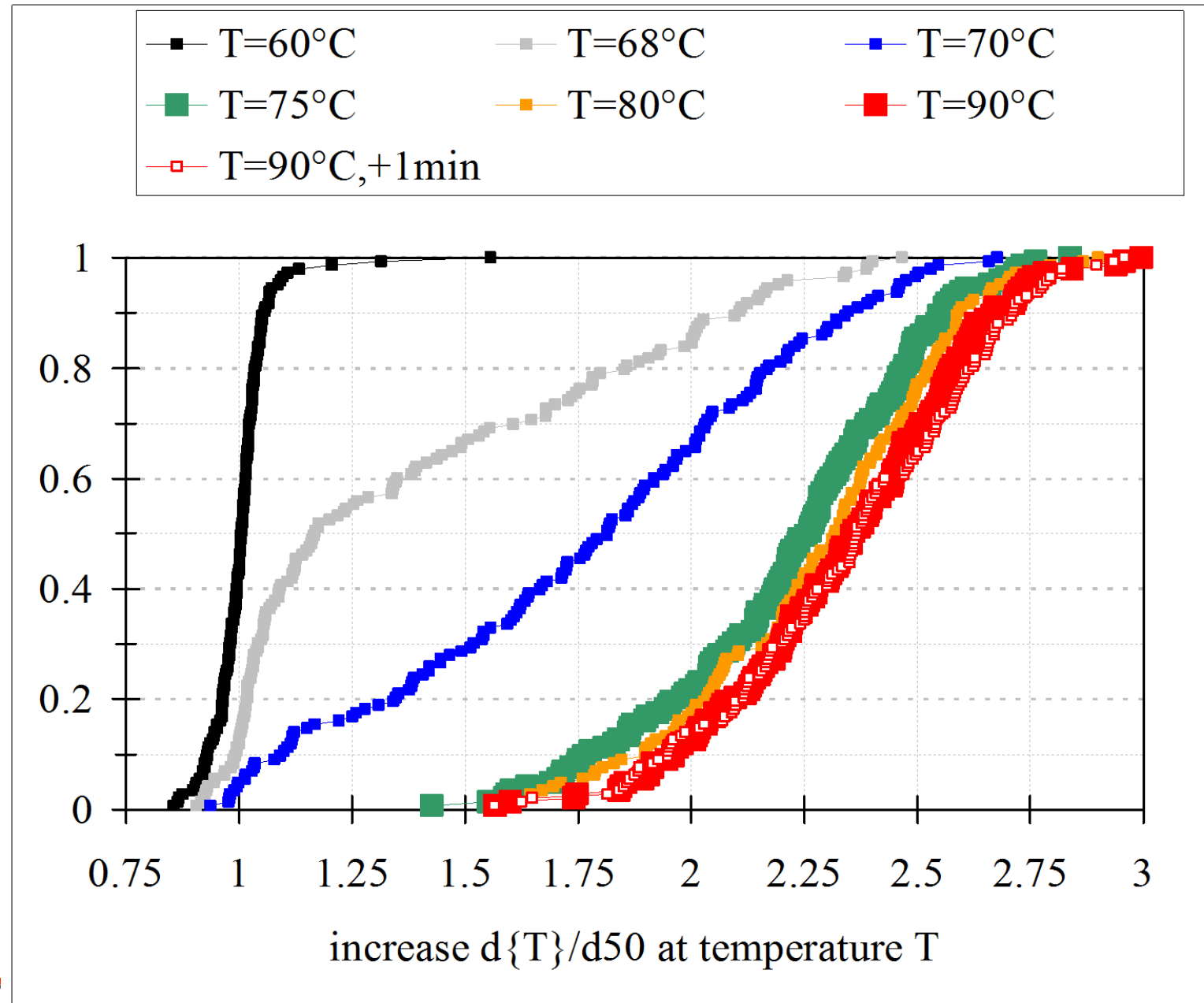




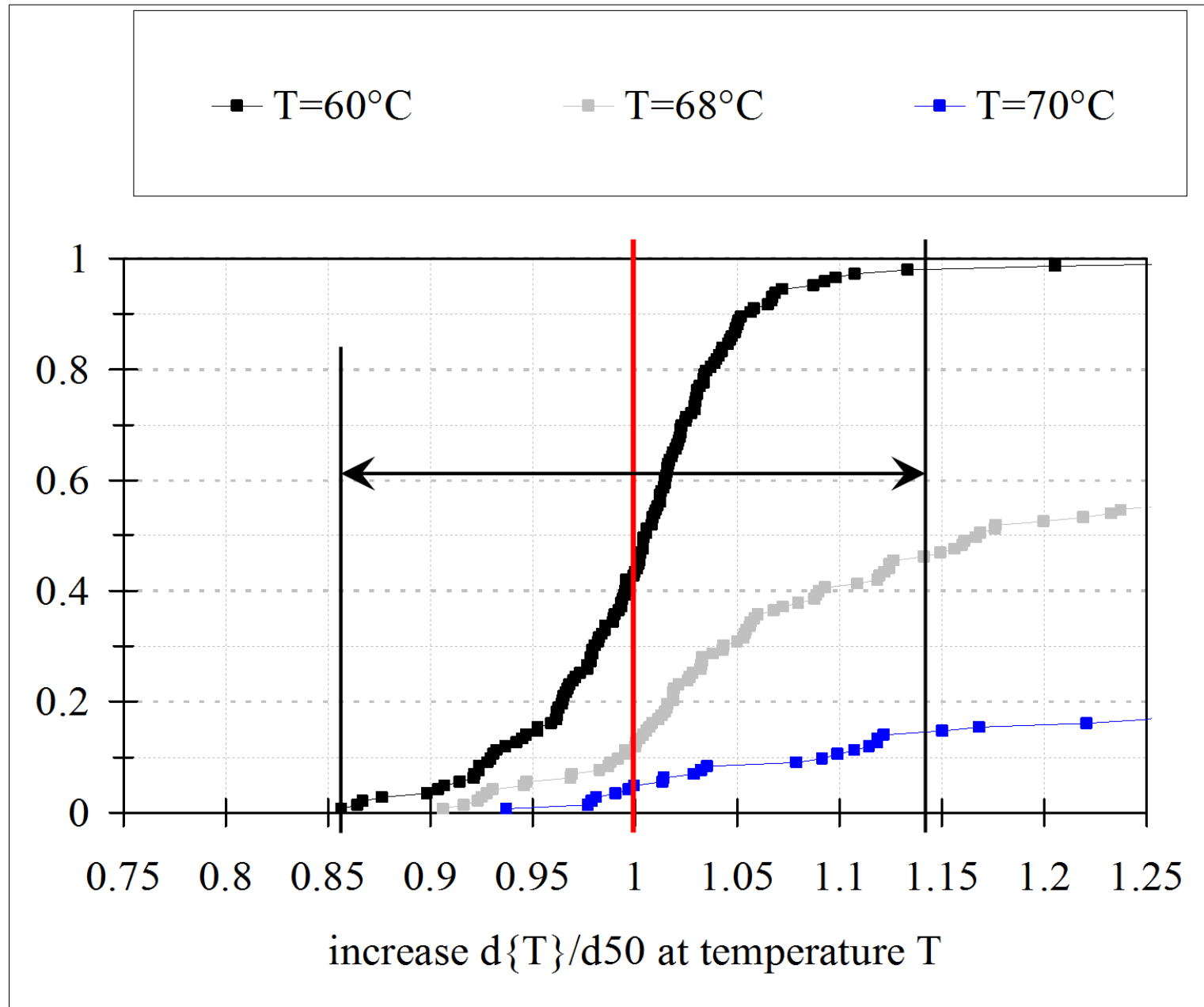
swelling onset and initial granule size



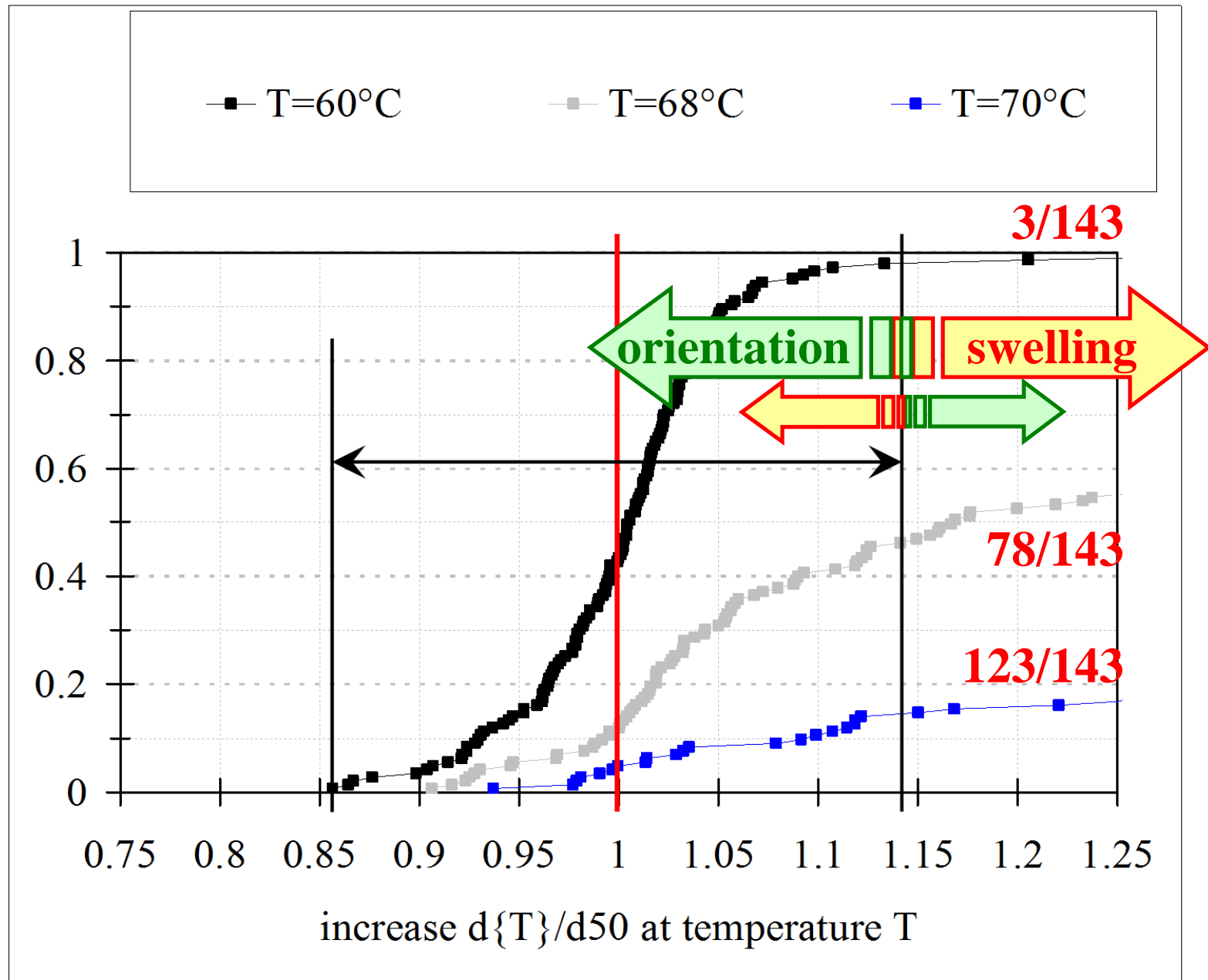


swelling and granule size increase

swelling and granule size increase



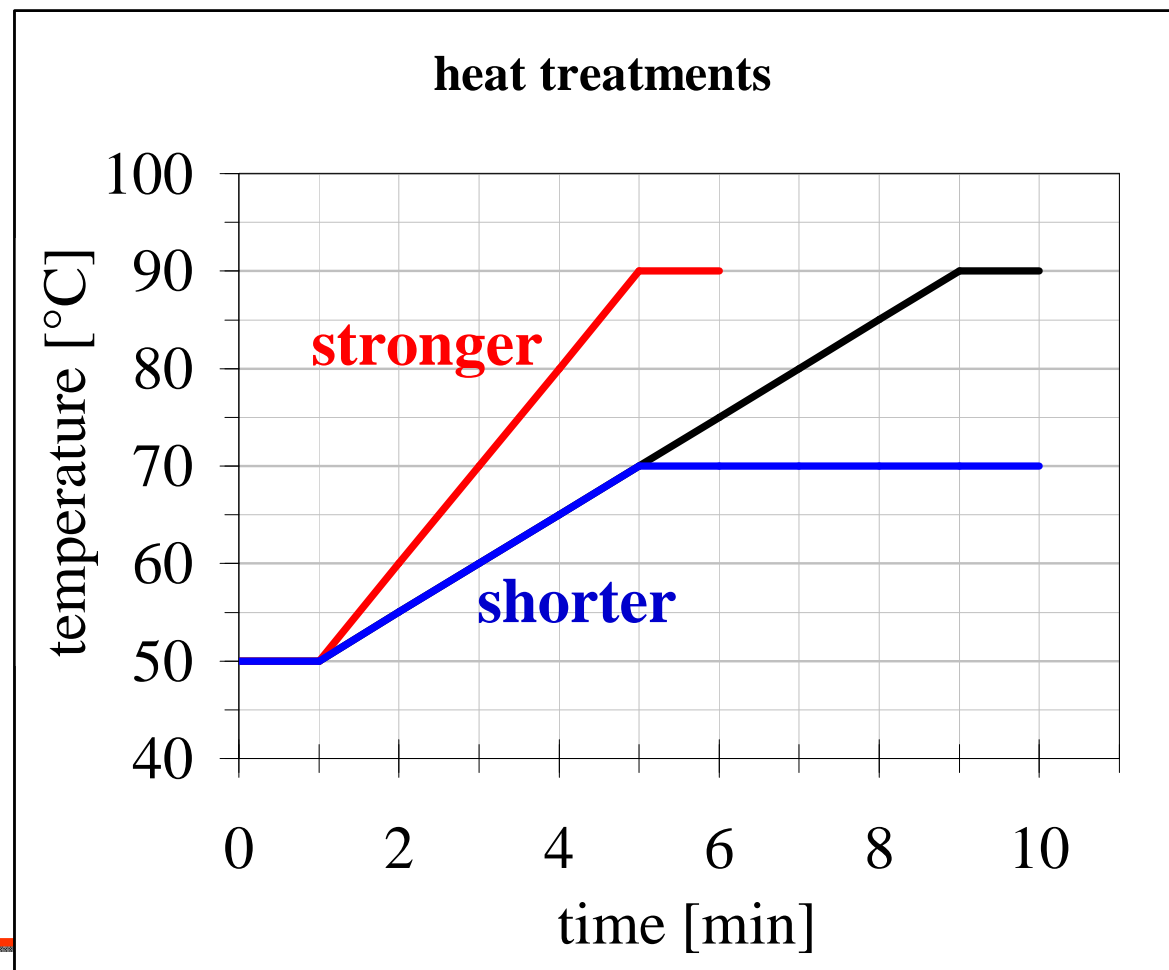
influence of granule orientation (...!!!)



- ❑ 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

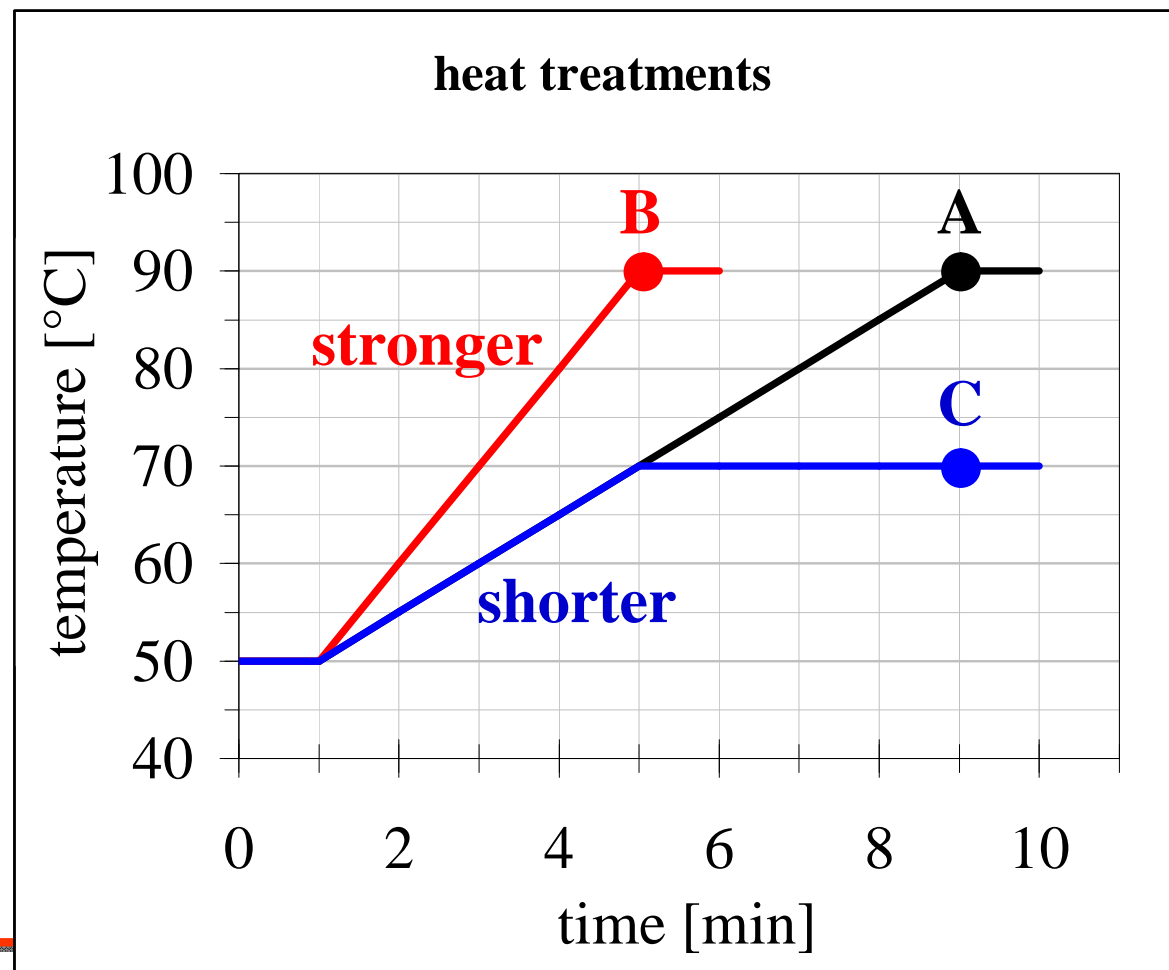
□ future work:

- ✓ to assess the influence of heating rate and duration



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□ future work:

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

