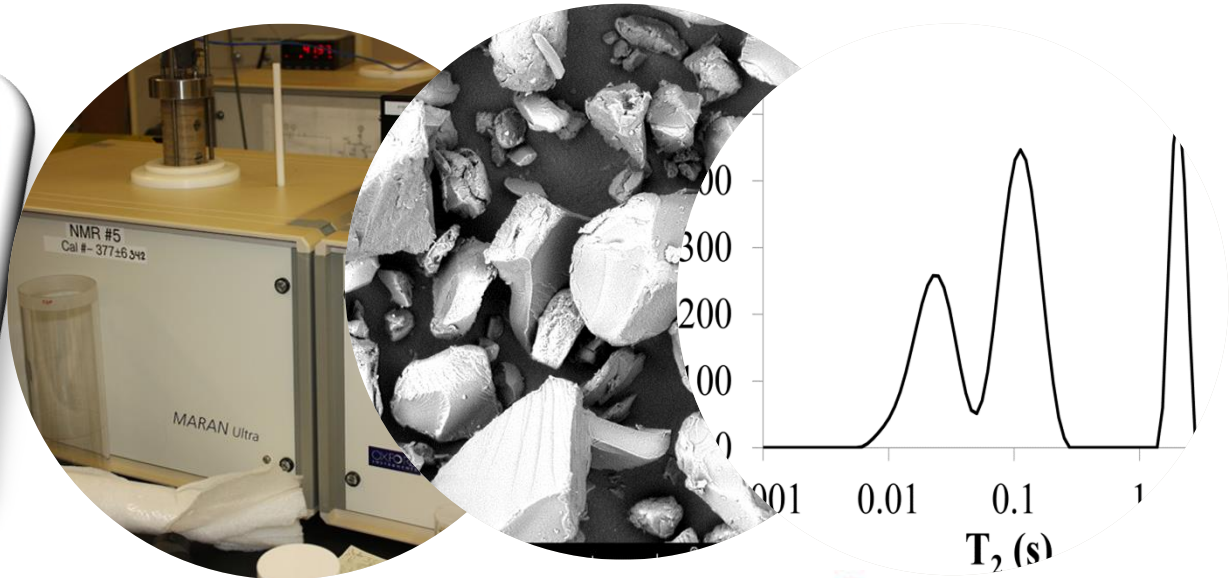


Understanding water-binding properties of whey protein microparticles using NMR

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Atze Jan van der Goot

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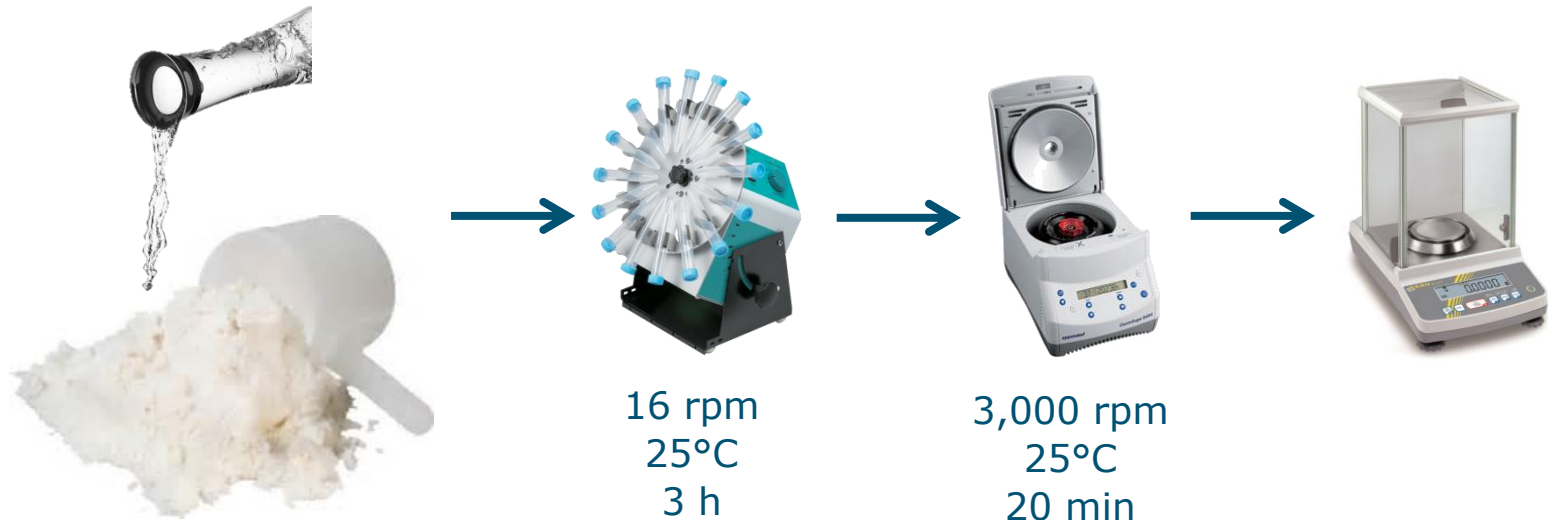


Water-binding capacity

- Important property for, amongst others, protein samples
- Several definitions and terms used in literature
- Variation in methods used
 - Various hydration methods (amount of water, time)
 - With or without external force (centrifugal vs compression, difference in strength force, time)
 - Differences in calculations (dry material or dried pellet, g water/g dry matter or g water/g protein or percentage)

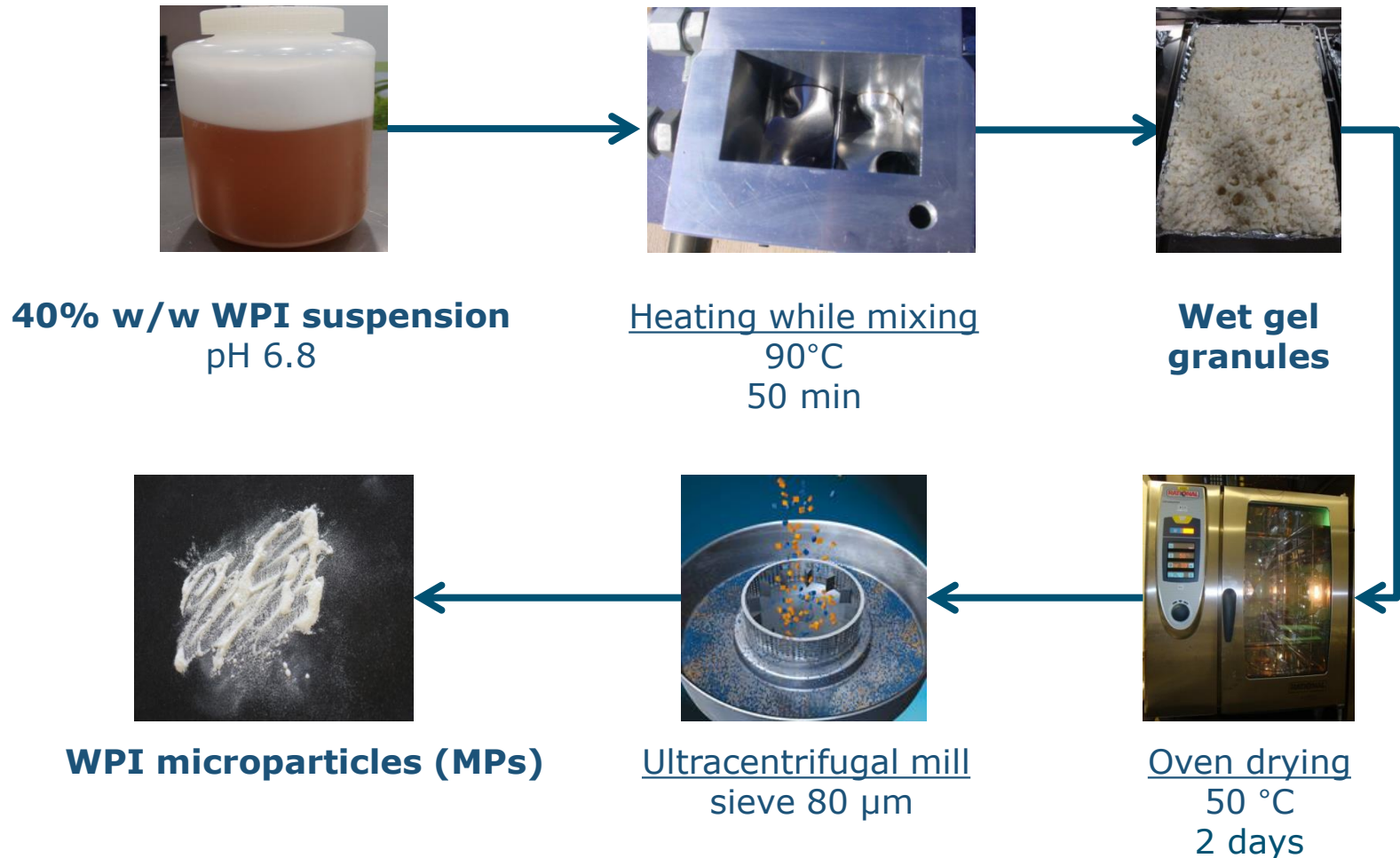
Defining water-binding capacity

Water-binding capacity is the ability of a protein sample present in excess water to bind water when subjected to an external force

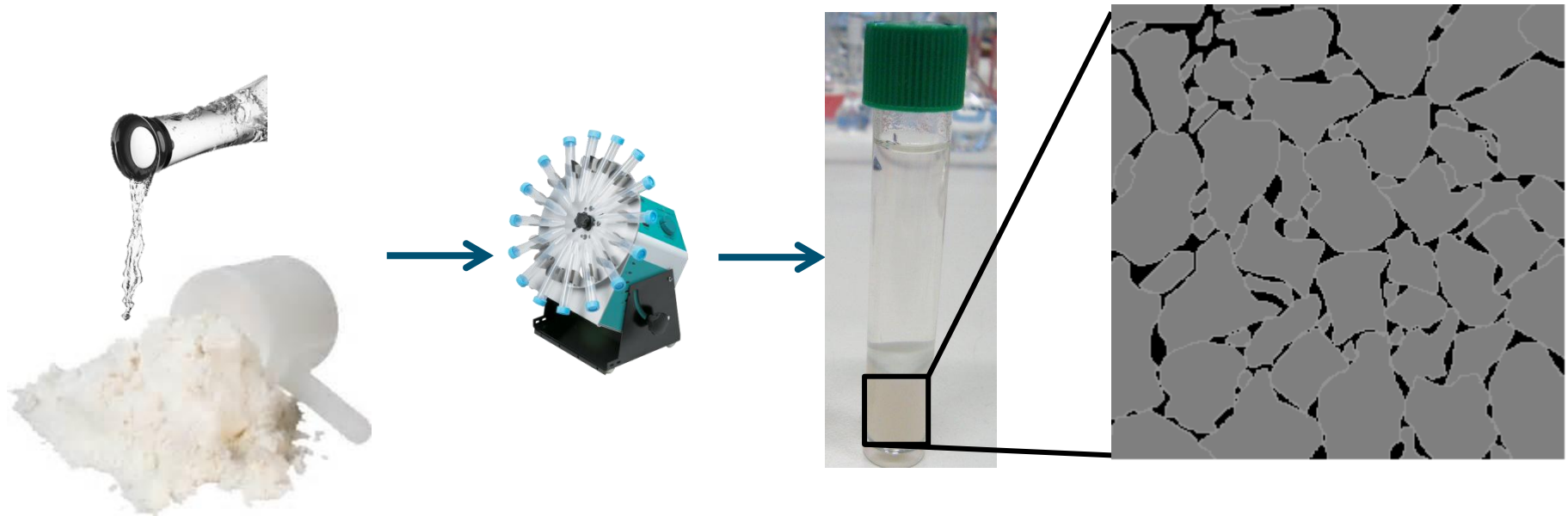


$$WBC \text{ (g water/g dry_matter)} = \frac{(w_{\text{pellet}} - w_{\text{dry_matter}})}{w_{\text{dry_matter}}}$$

Swellable whey protein microparticles can be created by heat-induced gelation

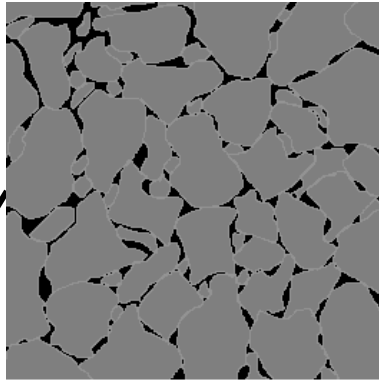
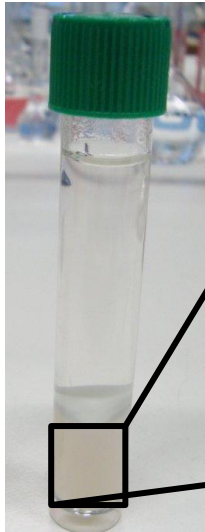


It is expected that water between the whey protein microparticles is removed by centrifugation

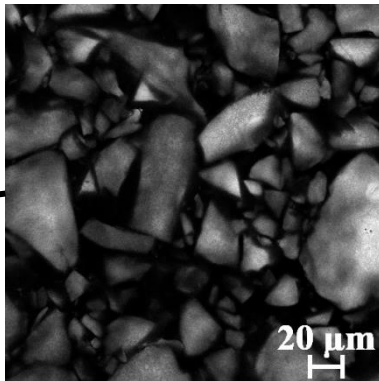


WBC = 1.3 g water /g dry matter

Can the role of water between the particles be neglected?



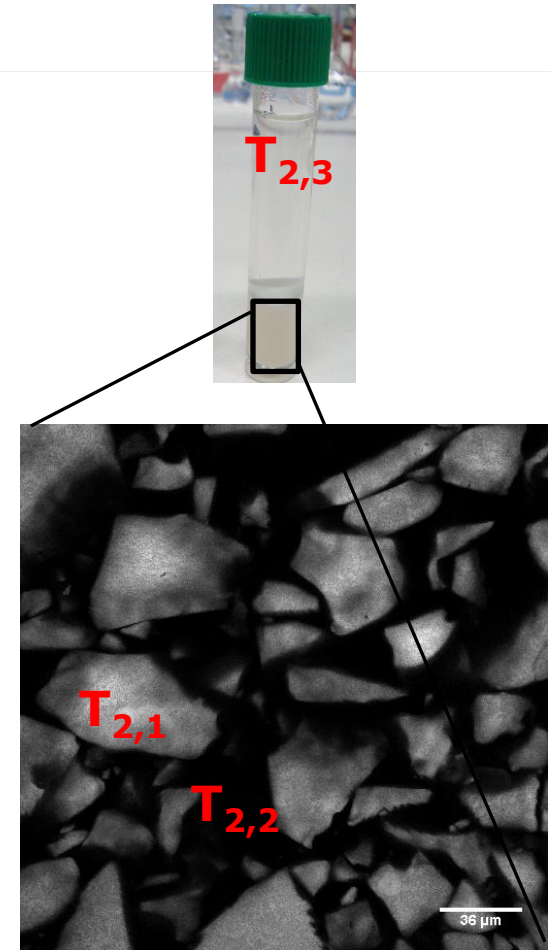
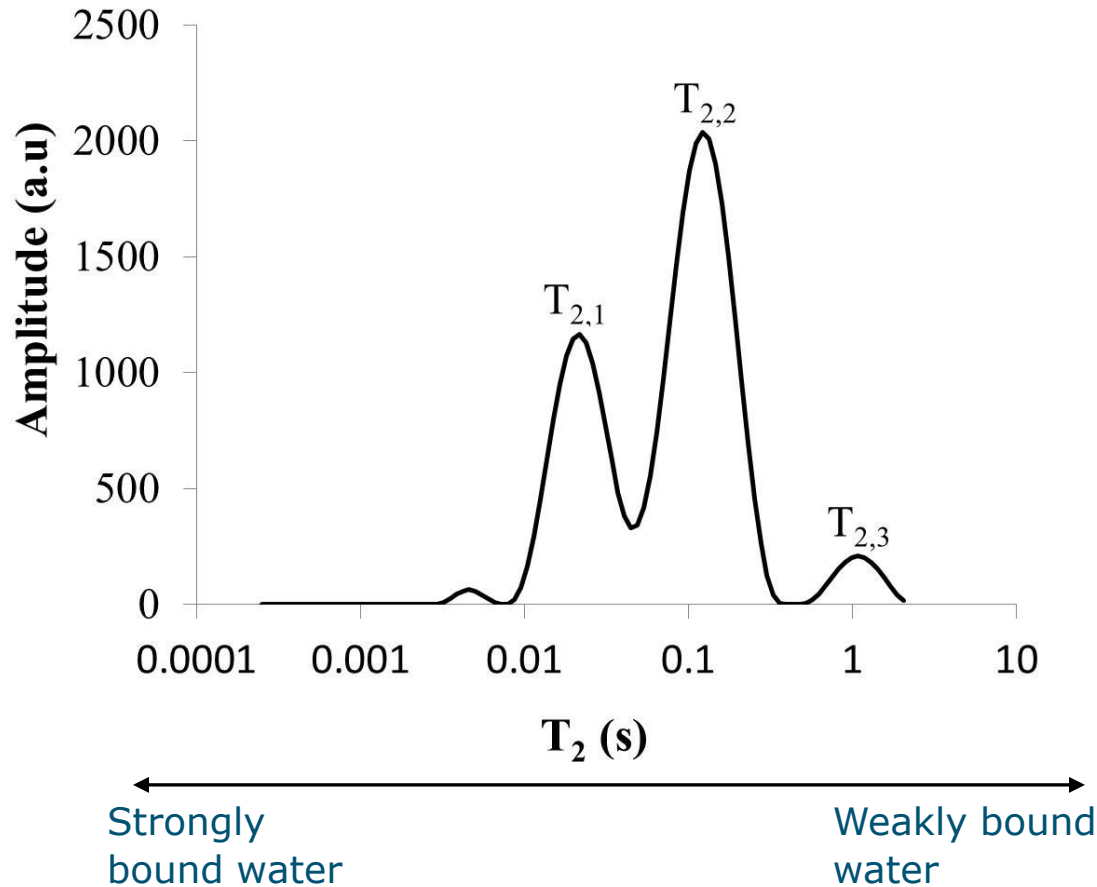
WBC = 1.3 g water /g dry matter



WBC = 3.7 g water /g dry matter

Question: Does water between the MPs play a significant role in the WBC of the pellet?

Three water fractions of a whey protein microparticle pellet



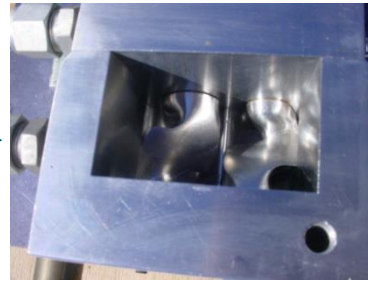
T₂ free water = 2.0-2.5s

Changing swellability of whey protein microparticles

- Changing pH
- Addition DTT
- Addition genipin
- Addition T-gase



40% w/w WPI suspension
pH 6.8

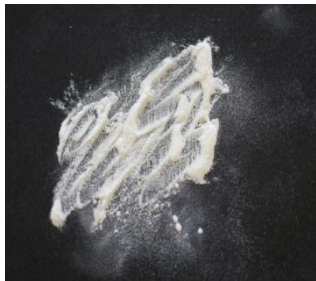


Heating while mixing
90°C
50 min

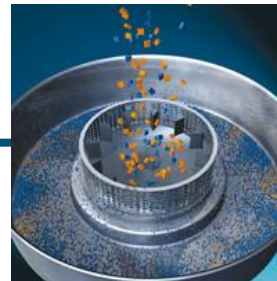


Wet gel granules

- Incubation in
 - DTT
 - DTT and NEM
 - genipin
 - T-gase solution



WPI microparticles (MPs)

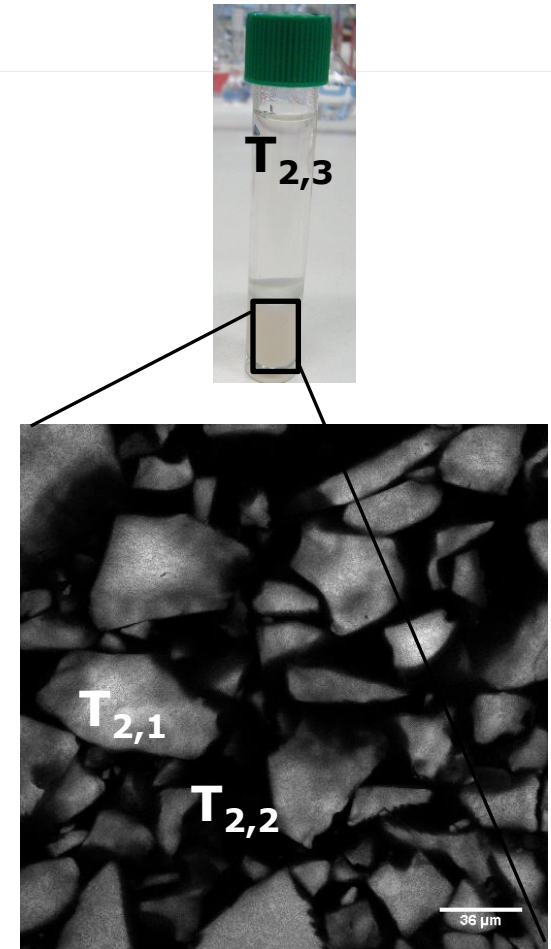
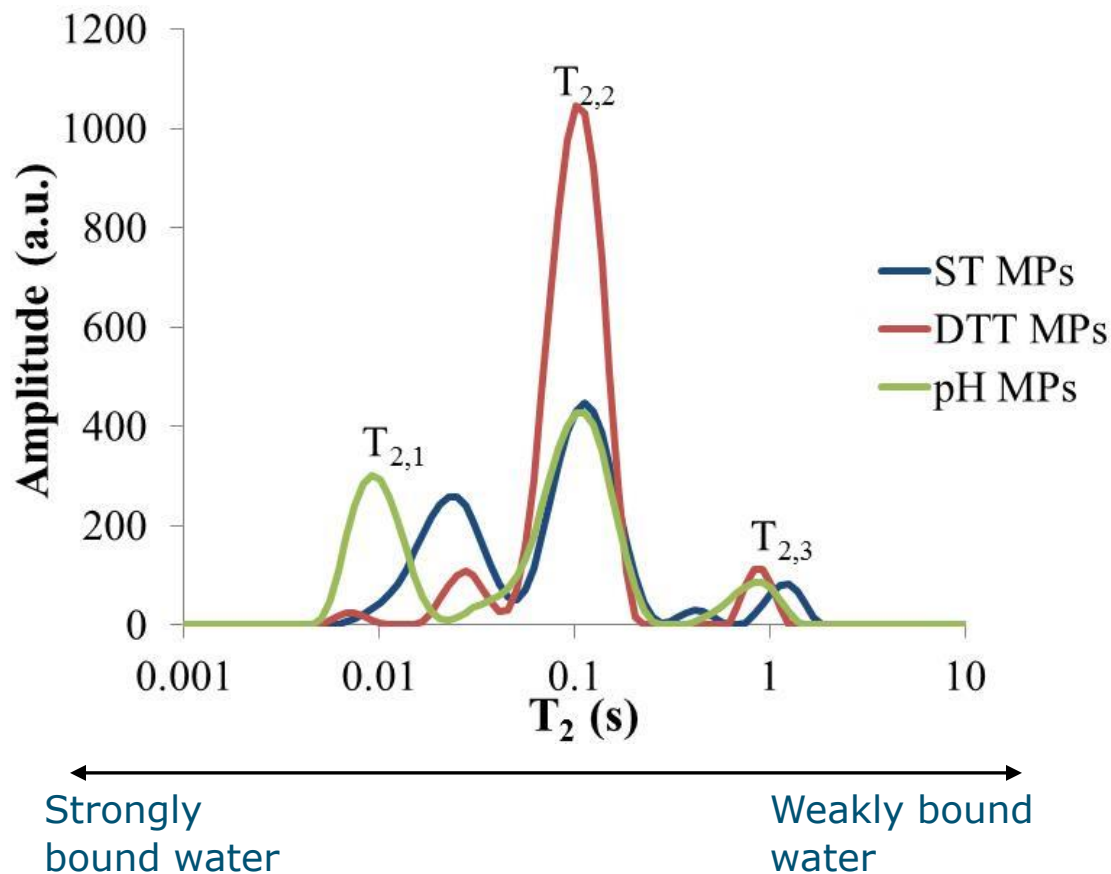


Ultracentrifugal mill
sieve 80 µm



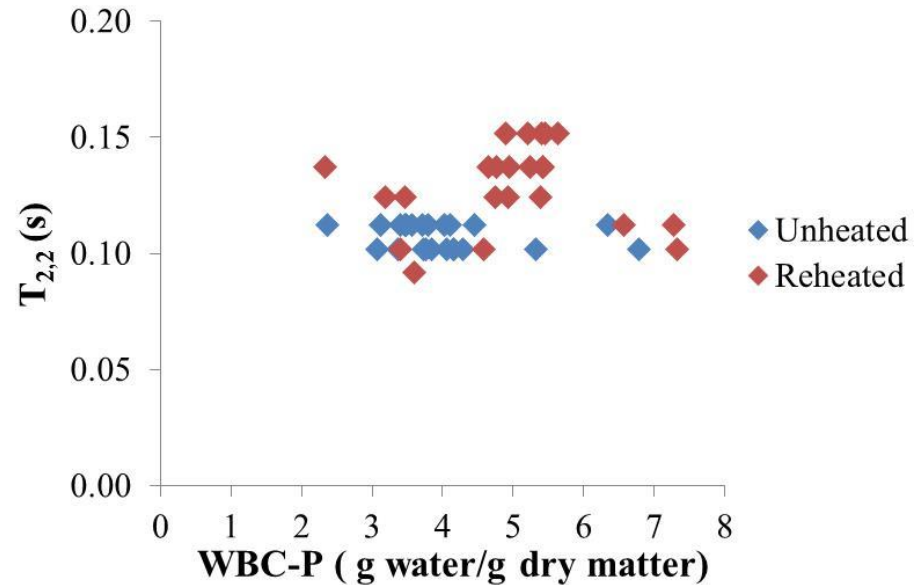
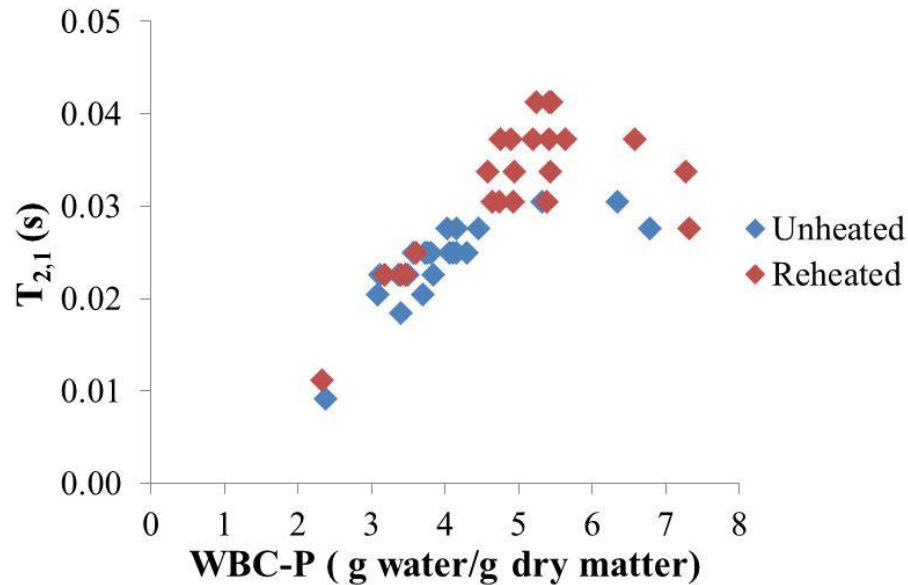
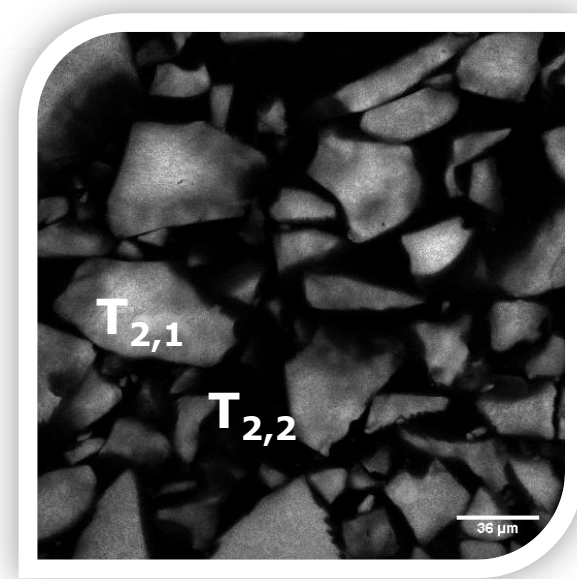
Oven drying
50 °C
2 days

Spectra of whey protein microparticles with an altered water-binding capacity

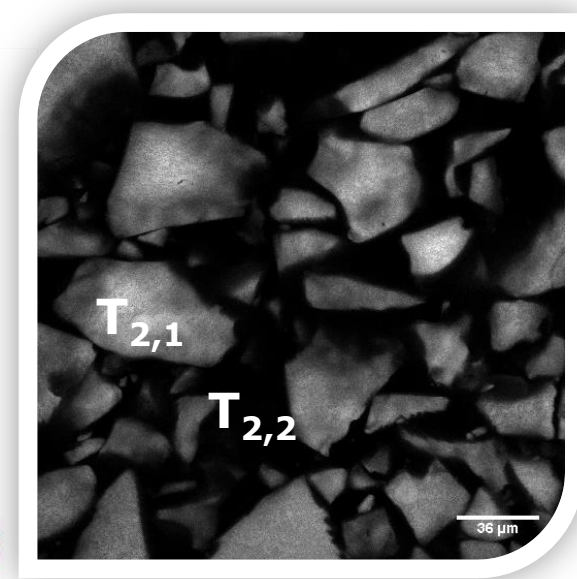
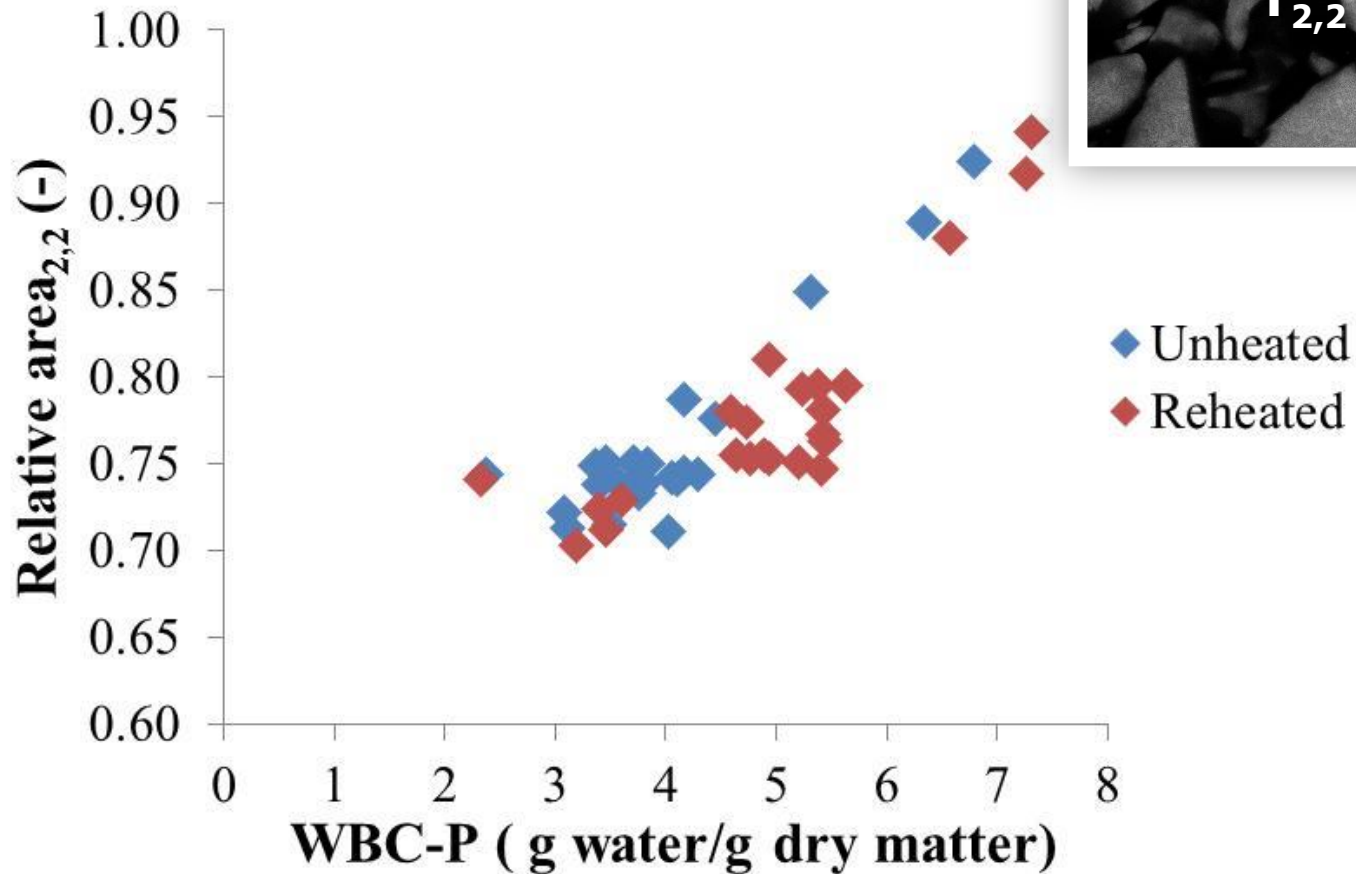


T_2 free water = 2.0-2.5s

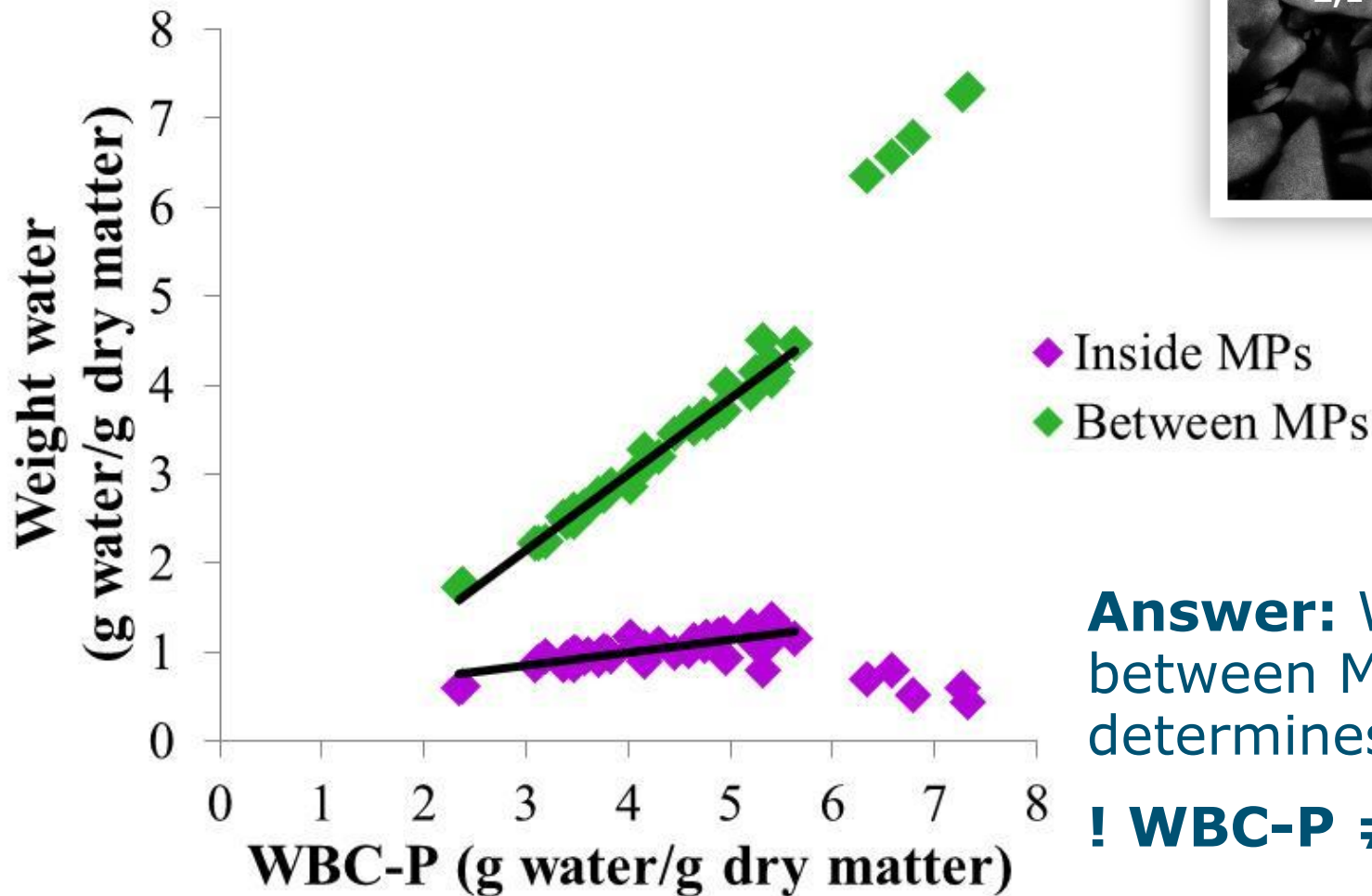
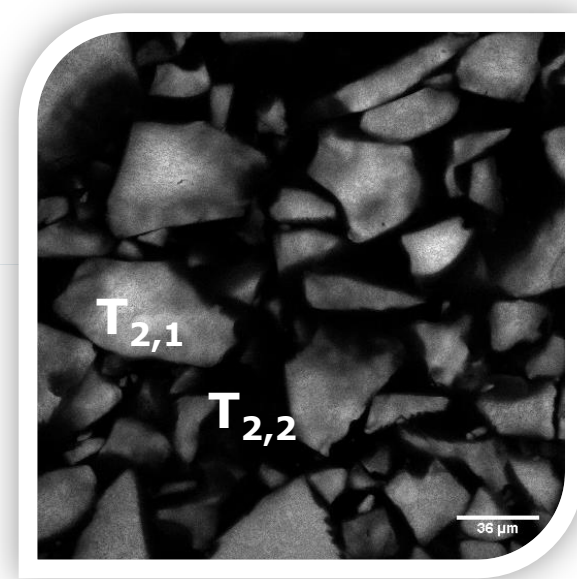
Increase in $T_{2,1}$ with increasing WBC-P while $T_{2,2}$ stayed constant



Increase in $A_{2,2}$ with increasing WBC-P



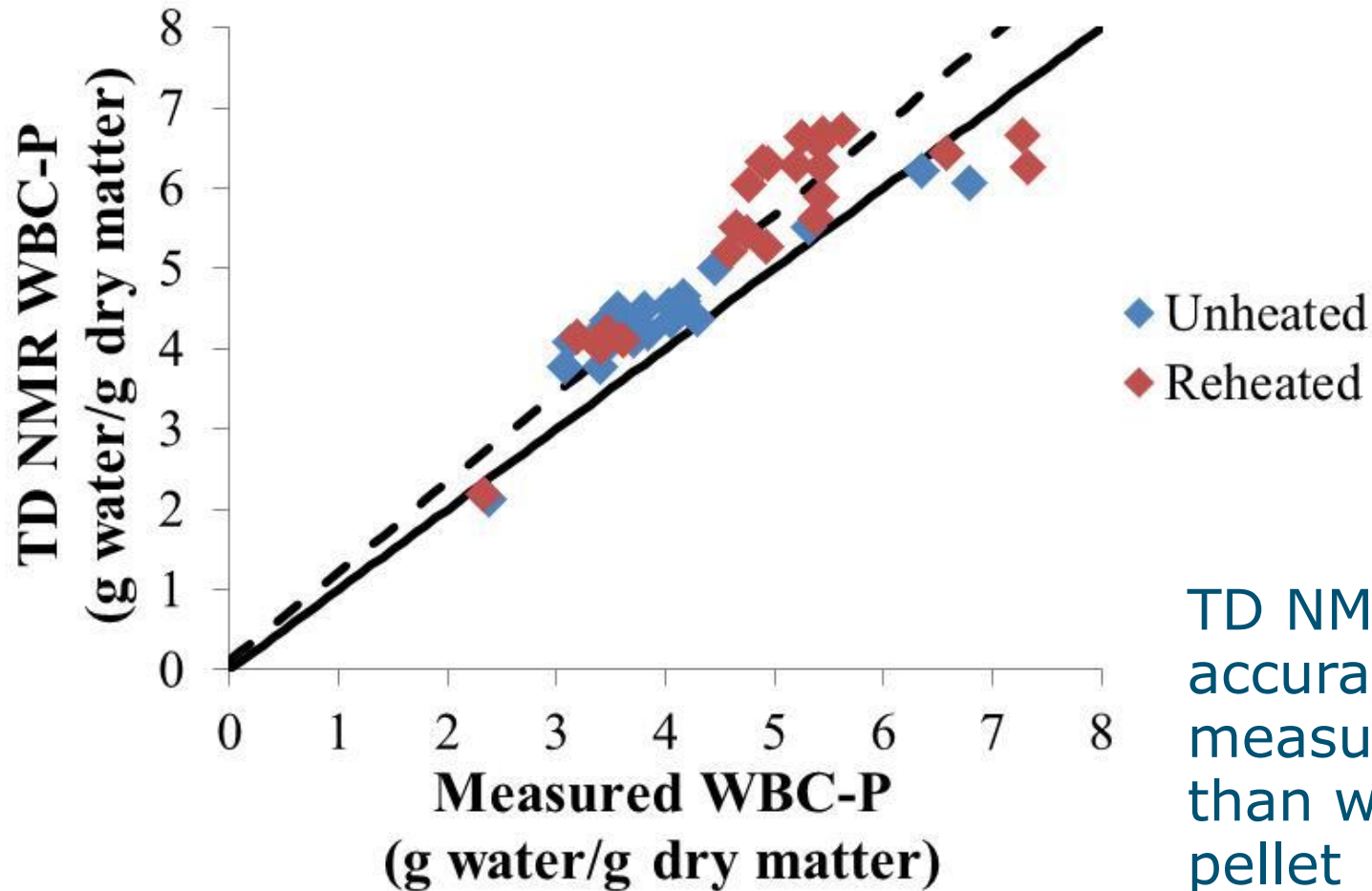
WBC-P mainly determined by water between the MPs



Answer: Water between MPs mainly determines the WBC-P

! WBC-P \neq WPC-MPS

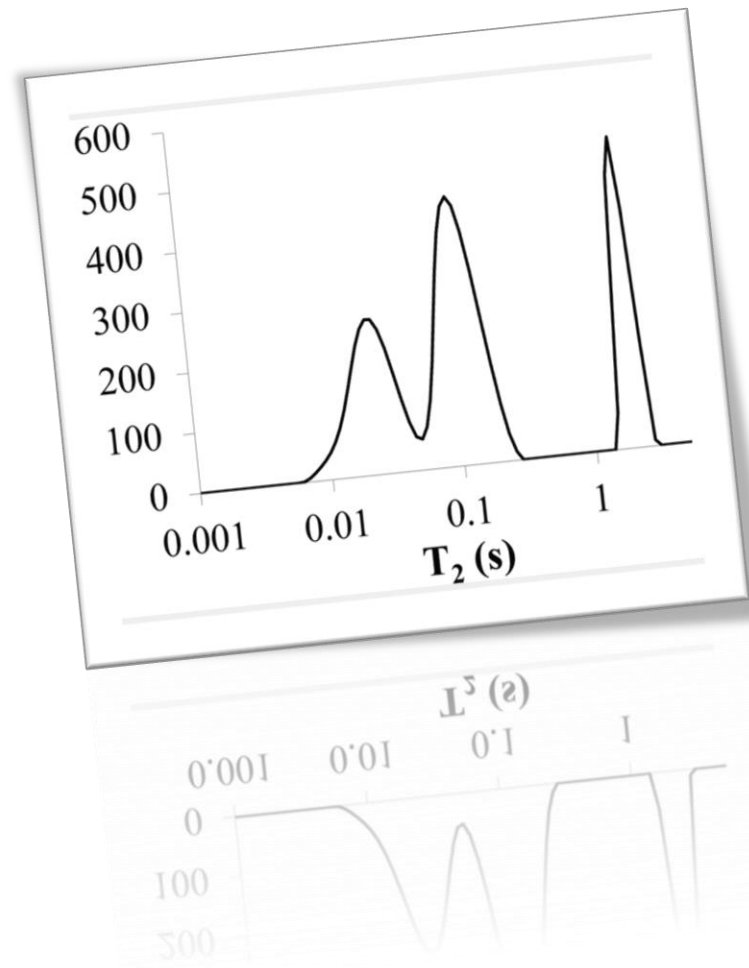
Difference in WBC obtained via TD NMR and weighing the pellet



TD NMR is more accurate in measuring the WBC than weighing the pellet

Conclusions

- TD NMR can be used to distinguish water between MPs from water within MPs in MP pellets
- WBC-P is mainly determined by water between the MPs
- $\text{WBC-P} \neq \text{WBC-MPs}$
- TD NMR measures WBC-P more accurately than using the weight of the pellet obtained after centrifugation



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