WHC in mushroom in relation to its material property

Conceptual process design of mushroom processing

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Food Process Engineering

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Background

Canned mushroom: production process

Fresh mushroom → Vacuum Hydration → Storage → Blanching at 90°C → Slicing at 20°C → Sterilising in can at 130°C → Canned mushroom 70%

Fresh mushroom

Vacuum Hydration

Storage

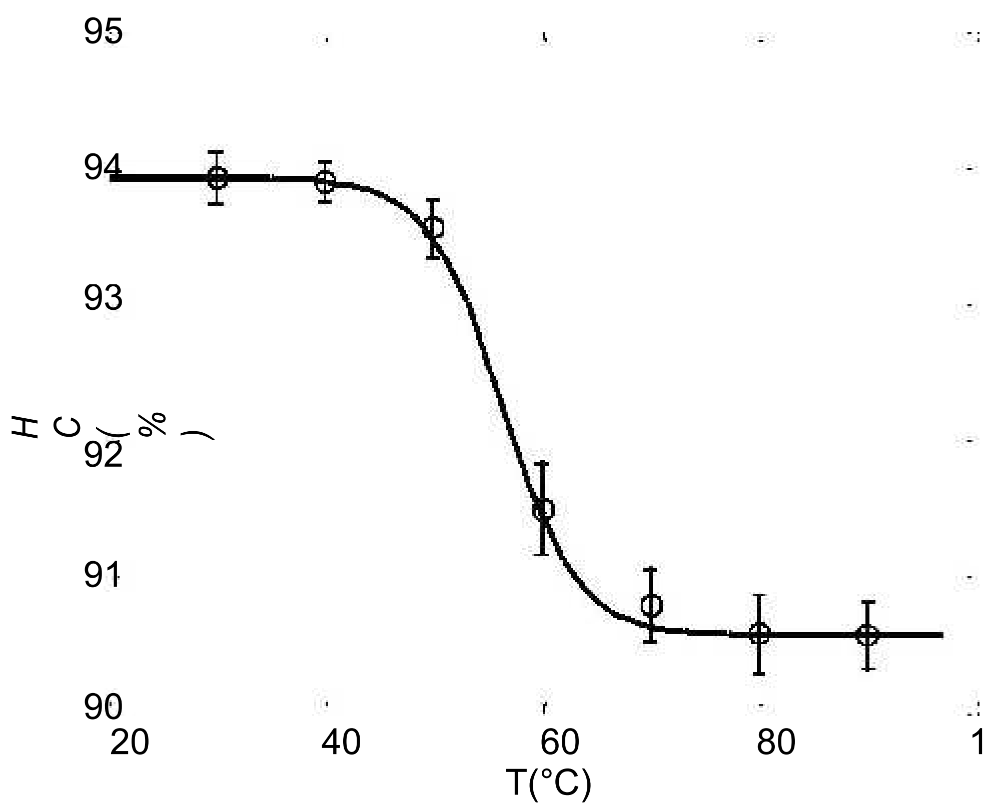
Blanching
at 90°C

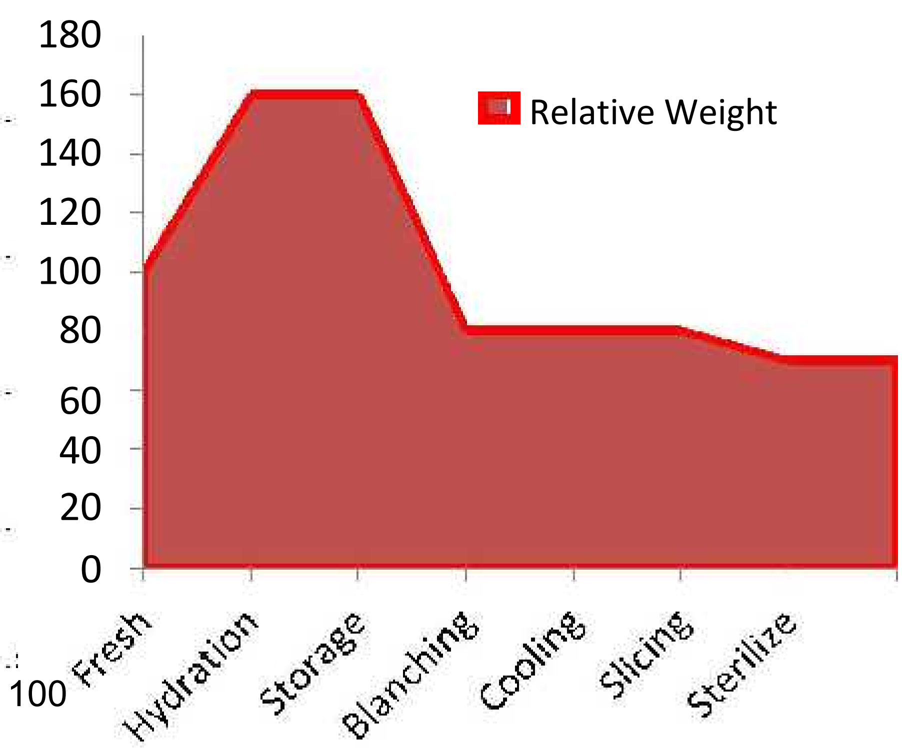
Slicing
at 20°C

Sterilising in can
at 130°C

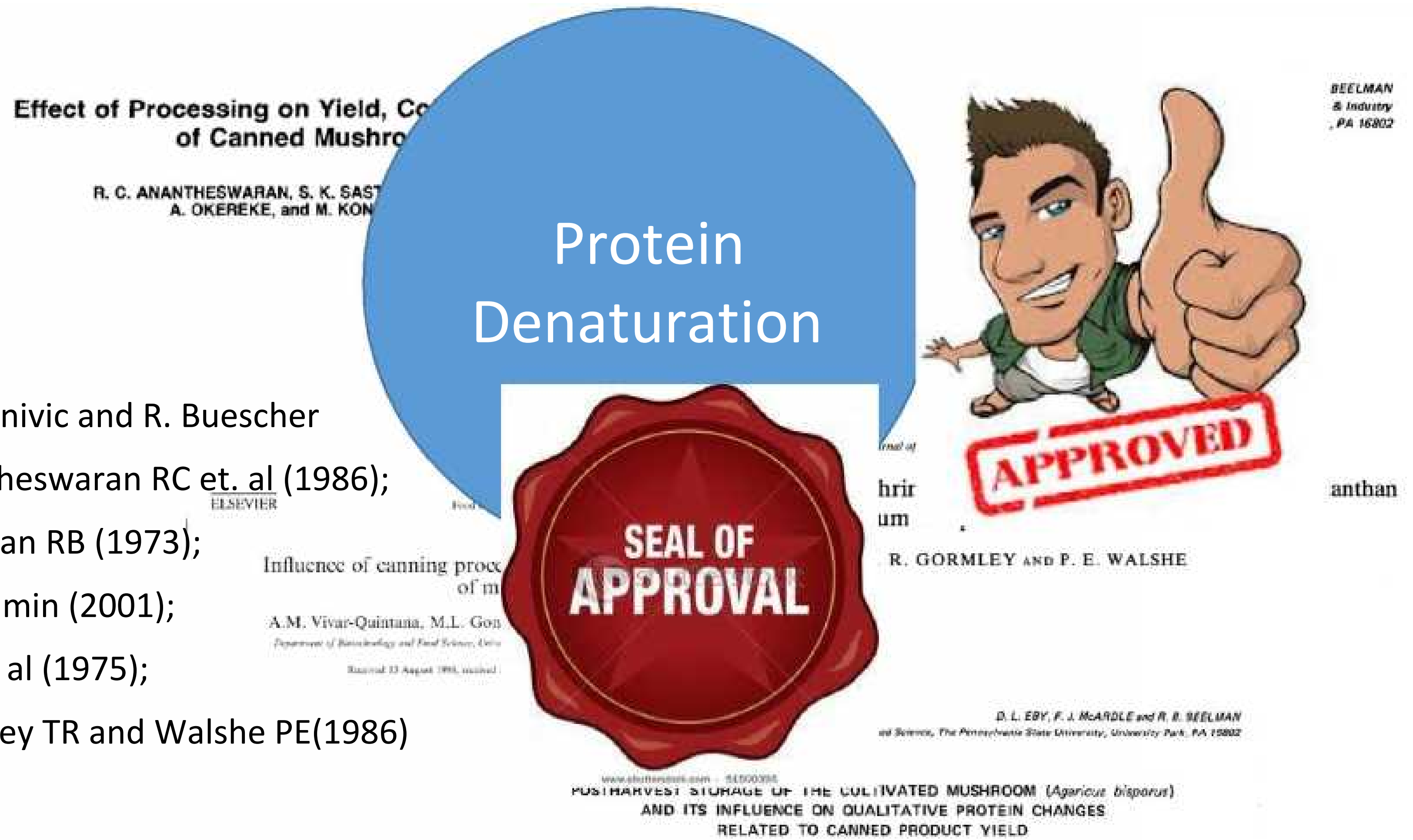
Canned mushroom
70%

Thermal processing shrink mushroom





....and Why?



S. Zivanivic and R. Buescher

Anantheswaran RC et. al (1986);

Beelman RB (1973);

Lin Zhimin (2001);

Eby et al (1975);

Gormley TR and Walshe PE(1986)

Objectives

- Describe the WHC loss in mushroom during thermal processing with the Flory Rehner's theory

Theory

WHC definition and understanding

Synonyms: water hydration capacity, water absorption, water-imbibing, water-binding etc.

Water Holding Capacity (WHC) –The ability of meat to retain its inherent moisture even though external pressures (like gravity, heating, centrifugation, pressing) are applied to it. This characteristic can be measured by drip loss, but other methods can be used as well (Honikel and Hamm, 1994; Honikel, 1998).

The ability of meat to retain both inherent water and added water is de-fined as water-holding capacity (WHC) (Grau and Hamm, 1956).

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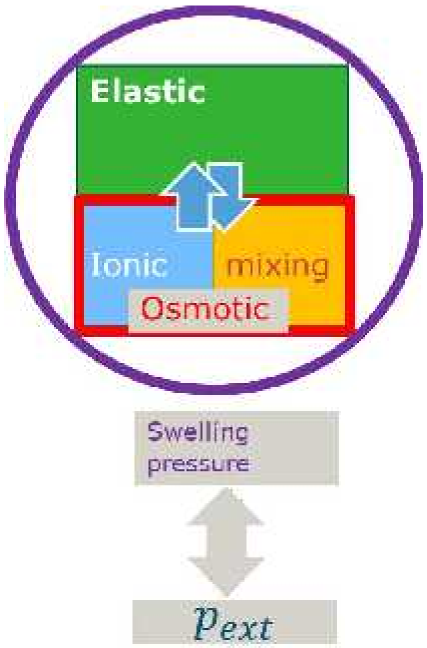
Water holding capacity: Flory Rehner's theory

- WHC: Ability to hold water under applied external force
- FR theory: WHC expressed as swelling of polymer
- Driving force for dewatering: -Π

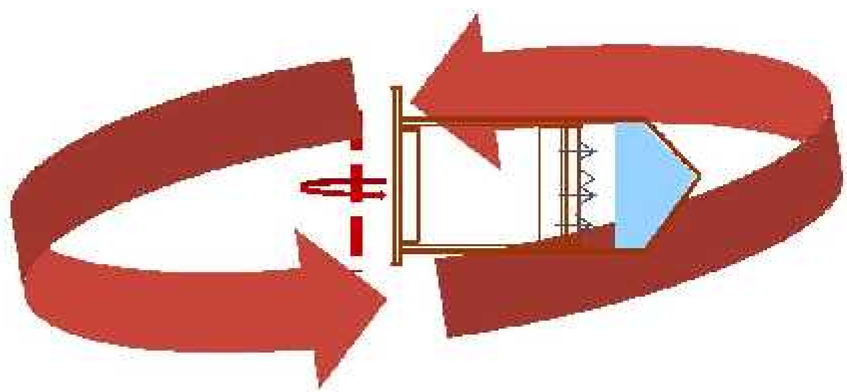


$\Pi = \Pi \; + \Pi \; - \Pi$

WHC-determination: centrifugation

- Sample centrifuged at various speed till equilibrium (= Π)

$\Pi = \Pi \; {}^{+}\Pi \; {}^{-}\Pi$



Centrifugation technique

The swelling contributions

$$p_{ext} = \Pi_{sw} = \Pi_{mix} + \Pi_{ion} - \Pi_{elas}$$

$$\Pi_{mix} = \frac{RT}{V_w}\left[\ln(\emptyset_w) + \left(1 - {}^{1}/_{N_{eff}}\right)(1 - \emptyset_w) + \chi_{eff}(1 - \emptyset_w)^2\right]$$

Flory Huggin's Theory

$$\Pi_{ion} = \frac{RT}{v_w} log(a_{w,ion})$$

$$\Pi_{elas} = \frac{RT}{v_w} N_c \phi_0 \left[\frac{1}{2}\left({}^{\phi}/_{\phi_0}\right) - \left({}^{\phi}/_{\phi_0}\right)^{2/3}\right]$$

Calculated: N_{eff}, χ_{eff}

Estimated: N_c, ϕ_0

Calculation of mixing pressure

- Mixing pressure was computed from the composition of blanched mushroom (Sman, 2013)[1]

$$\Pi_{mix} = \frac{RT}{V_w}\left[\ln(\emptyset_w) + \left(1 - {}^{1}/_{N_{eff}}\right)(1 - \emptyset_w) + \chi_{eff}(1 - \emptyset_w)^2\right]$$

$$\frac{1}{N_{eff}} = \frac{\sum_{i \neq w} \phi_i / N_i}{\sum_{i \neq w} \phi_i}$$

$$\chi_{eff} = \frac{\sum_{i \neq w} \phi_i \chi_{iw}}{\sum_{i \neq w} \phi_i}$$

Components	χ_{iw}	1/N$_i$
Mono – saccharides	0.27	0.16
Di- saccharides	0.53	0.84
Polymers	0.8	0
Proteins	0.8-1.4	0

- Protein denaturation affects χ_{eff} via an effect on $\chi_{1,p}$

1.Moisture sorption in a mixture of biopolymer, disaccharide and water, *Food Hydrocolloids, 32*

Modelling and curve fitting

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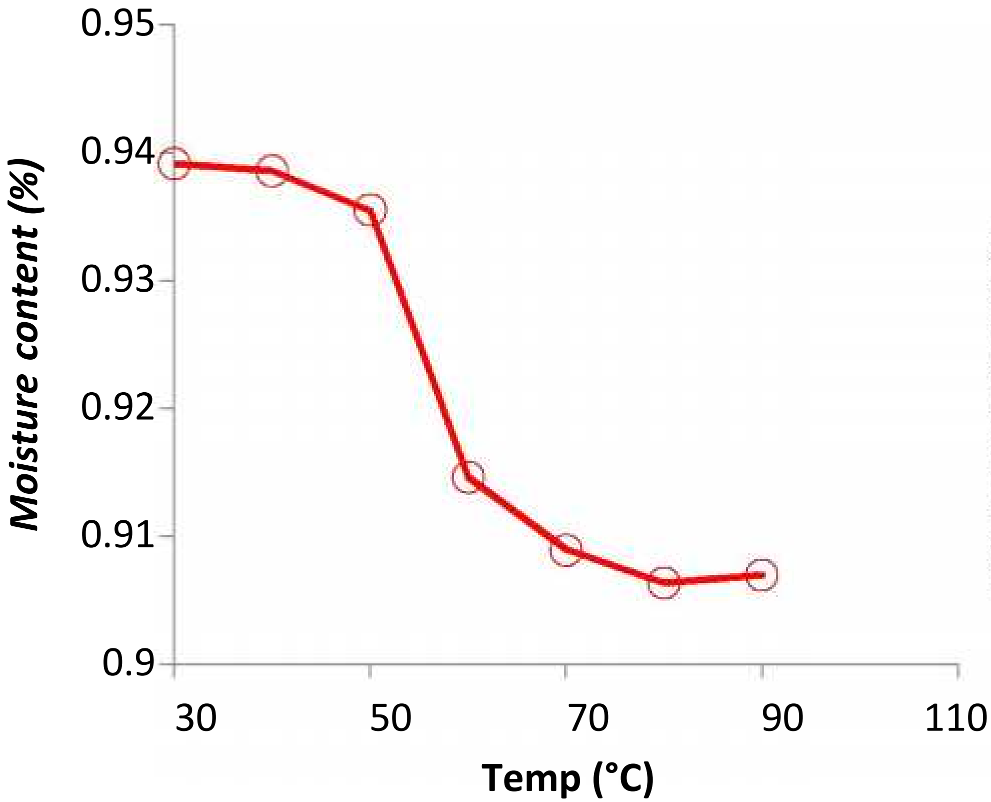
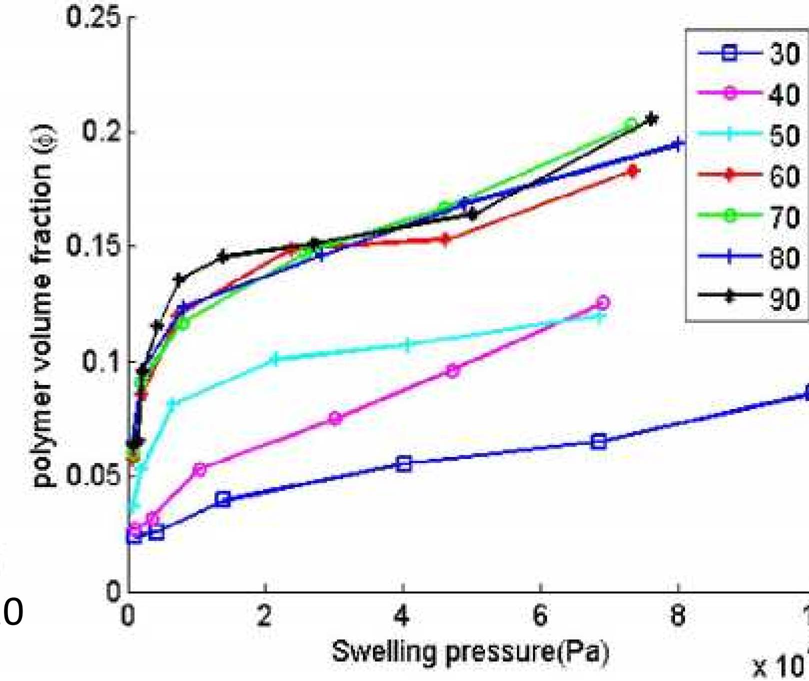
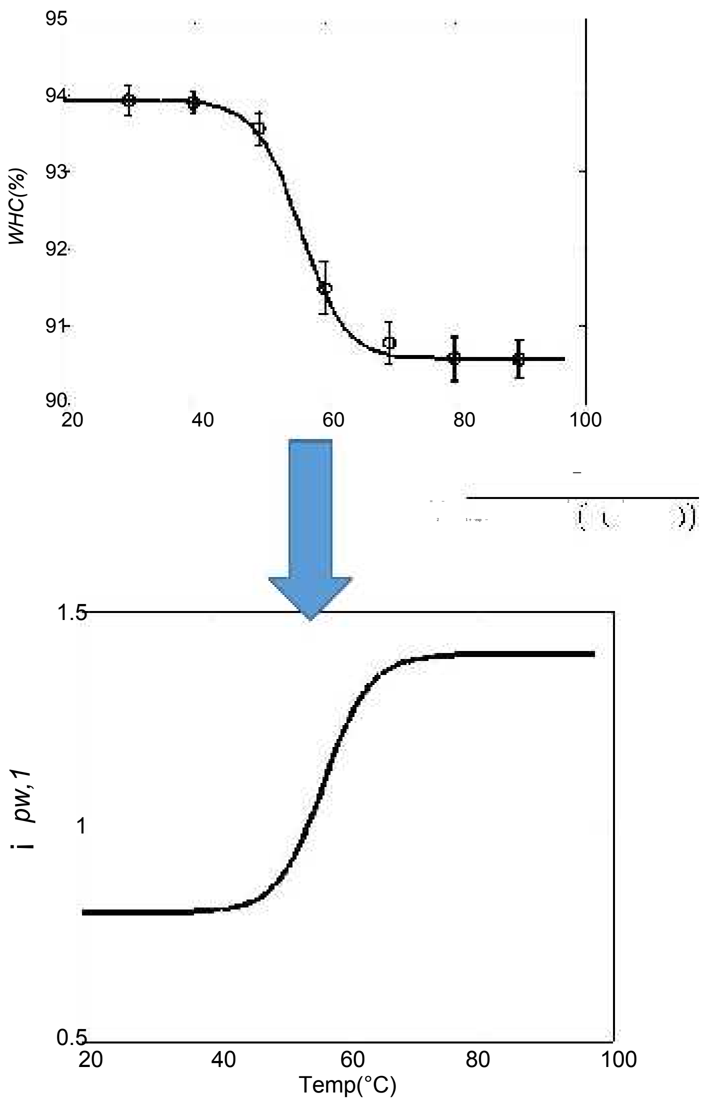
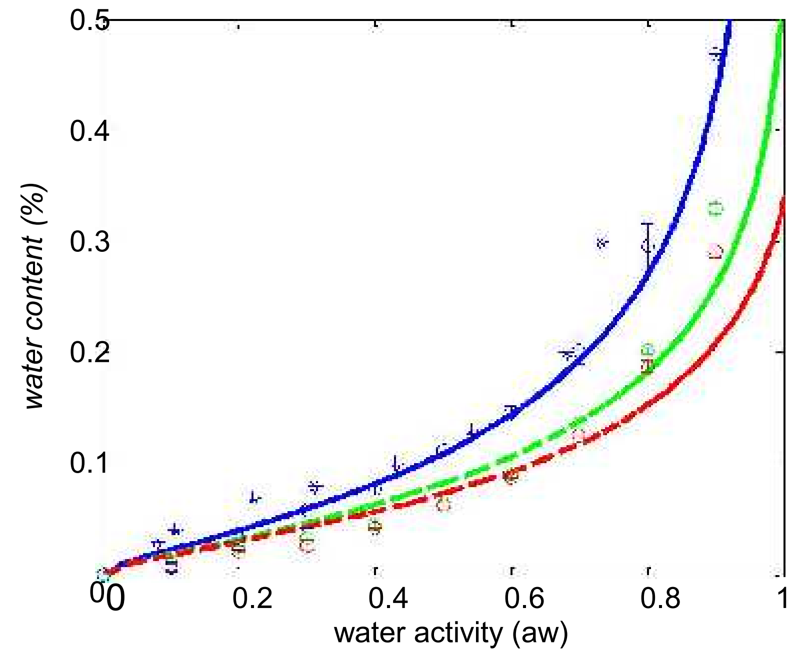
WHC in the heat treated sample





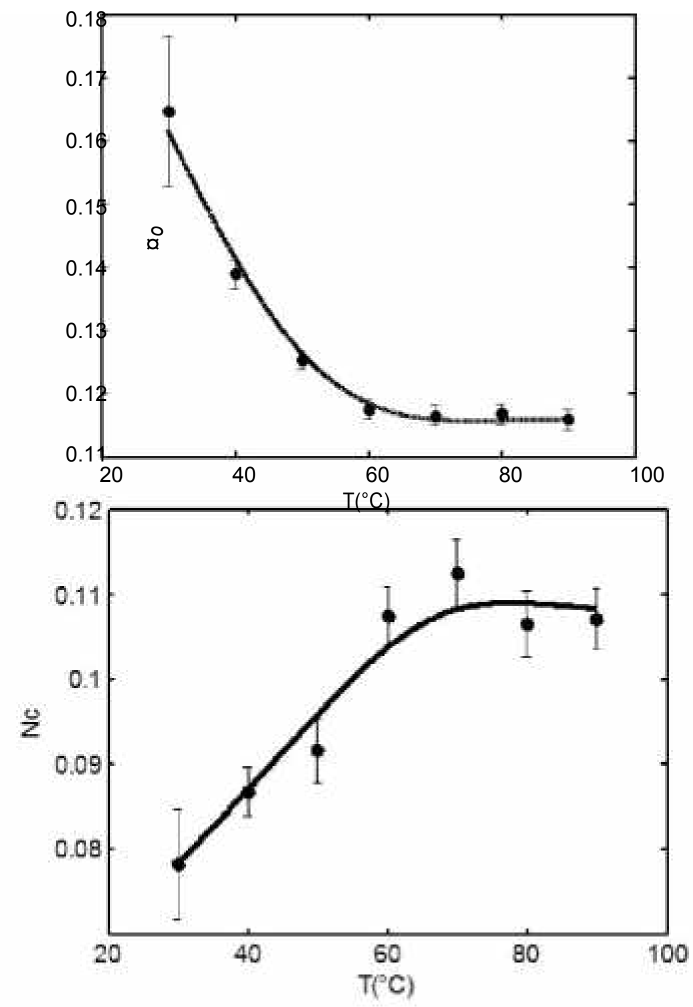
Assumptions and verification

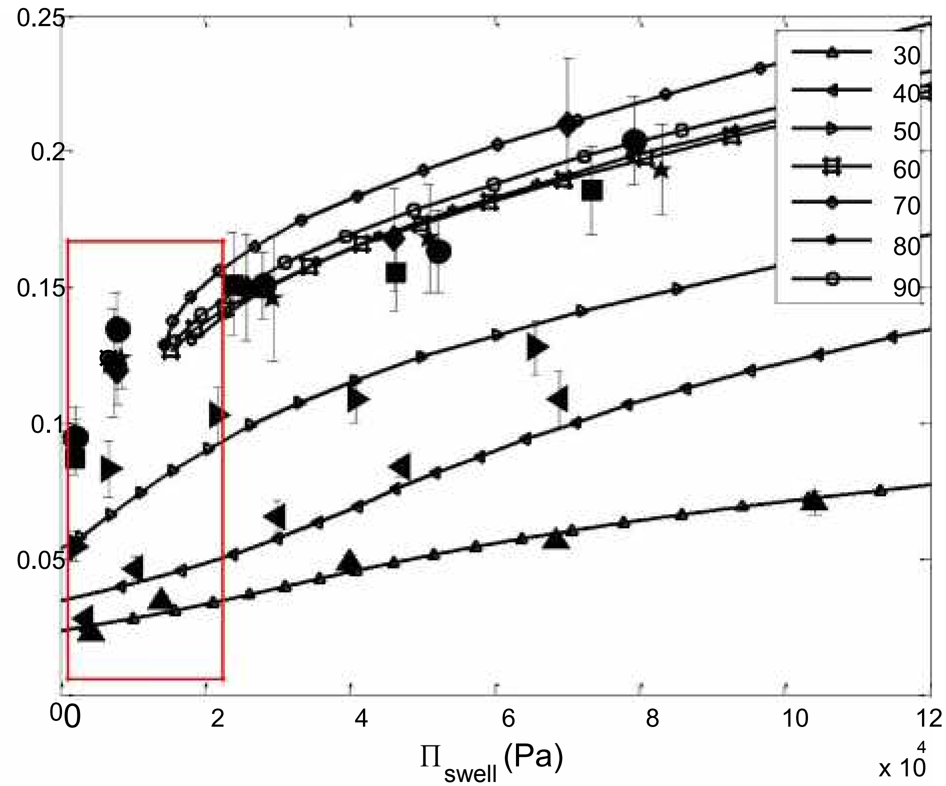




Sorption isotherm of freeze dried mushroom (30, 60 and 90C)

The fitting

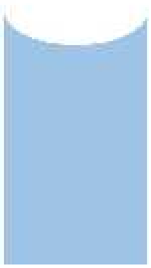


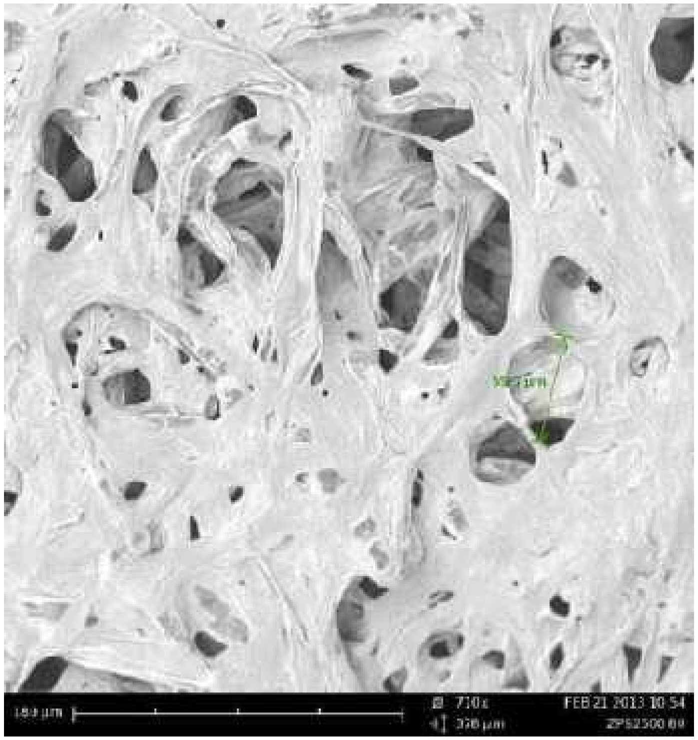


$\Pi = -$ 1

Summary and Conclusion

- Describes the water contained in the gel phase
- Need a consideration for water contained in the capillaries





Thank you for your kind attention

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