

# Change in Water Holding Capacity (WHC) of Mushroom during Processing: An Analysis Based on Flory Rehner's Approach.

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#### **1. Introduction**

The water holding capacity (WHC) in food science is widely used but often an ill defined and less understood term. In general, the term is used to refer water held within 3D network of polymer matrix in food. Its measurement is often empirical with no standard condition defined.

We try to study the WHC in mushroom in terms of the interaction of water with the mushroom polymers and polyols, as expressed in Flory Rehner theory. As the theory applies for cross linked network<sup>[1]</sup>, it is assumed to apply for cell wall materials. This theory has previously been used to understand the phenomena of water loss by meat when cooked <sup>[2]</sup>. In cooking meat, the loss of water is attributed to the denaturation of proteins. This has been accounted for by the change of the Flory-Huggins interaction parameter with temperature. We assume that the Flory-Rehner theory equally applies to white button mushrooms, which are rich in proteins.

This investigation of the thermodynamics concerning the water holding capacity in mushroom is expected to be useful for understanding and improving the water loss in the mushroom canning process. With a proper understanding of thermodynamics involved in the yield, this project aims at a complete redesign of the mushroom processing.

#### **2.** Objectives

#### 4. Results

and beef<sup>3</sup> ( blue

diamond) with

attributed to



Fig 4.2: DVS Sorption isotherm of blanched (red diamond) and non-blanched

- 1. Re-defining water holding capacity in terms of polymer water interaction
- 2. Study in changes in polymer water interaction parameter with change in temperature.

### 3. Theory

A hydrated mushroom consists of a gel phase containing cell wall material, water and solutes and pore phase containing capillary water and solutes. At equilibrium, the external pressure exerted is equal to the pressure exerted by gel:

 $\pi_{gel} = p_{ext}$ 

The gel phase is described by Flory-Rehner theory, with the mixing term including the contributions of the solute:

 $\pi_{gel} = \pi_{mix} + \pi_{ion} + \pi_{elas} = p_{ext}$  $\pi_{mix}$  is defined as

$$\pi_{mix} = +\frac{RT}{v_w} \left[ \ln(\phi_w + \left(1 - \frac{1}{N_{eff}}\right)(1 - \phi_w) + \chi_{eff}(1 - \phi_w)^2 \right]$$

and can be determined from sorption isotherm with relation  $\pi_{el}$  can be determined by exerting mechanical force

DT

(blue triangle) mushroom sample. The green solid lines show the values predicted by GAB model. Blanched mushroom  $(\chi_{eff} = 1.2)$  show lower retention of moisture at all the water activity value than unblanched ( $\chi_{eff}$ =0.8) (Courtesy: Unilever)



*Fig4.3:* **Left:**  $\pi_{ael}$  *plotted* (kP against polymer fraction in mushroom. Mixing pressure Ð (dotted line) is corrected for the expelled mannitol pressi **Right:** Elastic pressures in mushroom (the points) and carrot (the solid line) plotted against their polymer fractions  $[\pi_{mix} =$  $p_{ext} - \pi_{elas}]$ 



$$\pi_{el} = +\frac{RT}{v_w} N_c \left[ \frac{1}{2} (1 - \phi_w) - (1 - \phi_w)^{1/3} \phi_0^{2/3} \right]$$
$$\pi_{ion} = +\frac{RT}{v_w} \alpha (1 - \phi_w)^2$$

For an external centrifugal force applied to sample:

$$p_{ext}(h) = \Omega^2 R \int_0^h (\rho_p \emptyset + (1 - \emptyset) \rho_w) dh$$

## Conclusions

- Elastic contribution in carrot and mushroom is found same, which indicate that the contribution could be similar to vegetable cell walls.
- Mushroom and meat show similar behaviour in protein denaturation.

## References

1. Horkey F, McKenna GB (2007) Polymerr networks and gels. Physical Properties of Polymers 2.Van der Sman RGM (2012) *Thermodynamics of meat proteins*, Food Hydrocolloids 3.Van der Sman RGM (2007) Moisture transport during cooking of meat. Meat Science



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