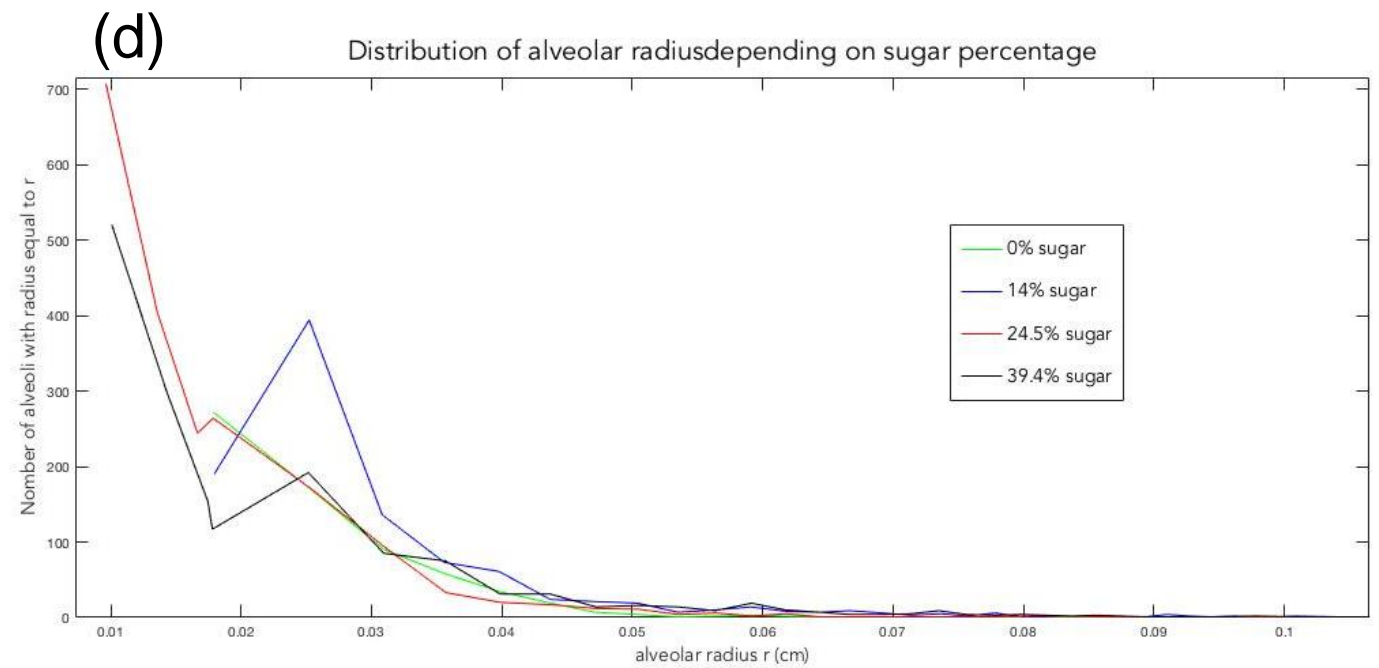
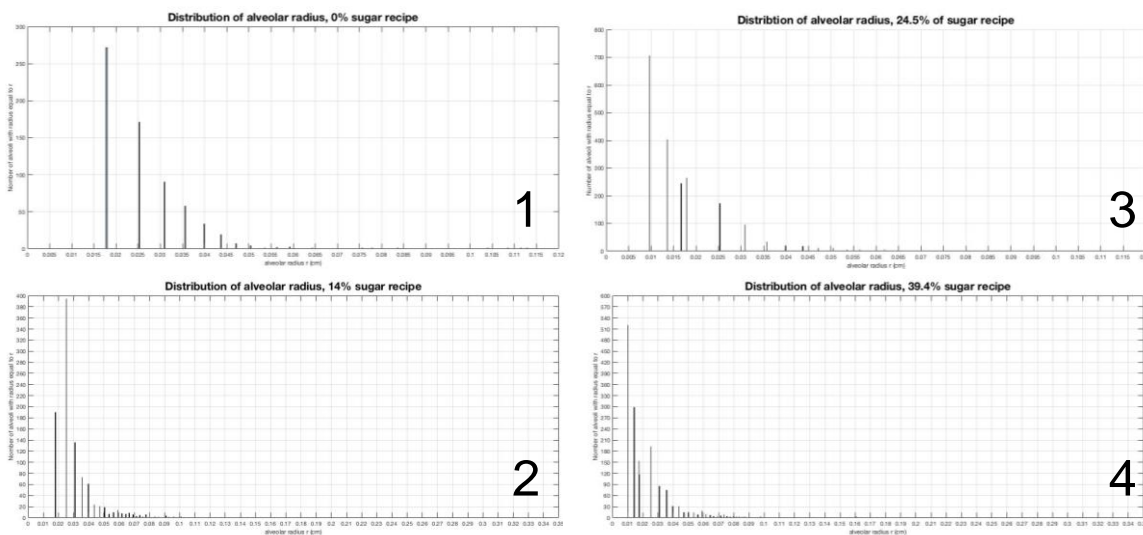
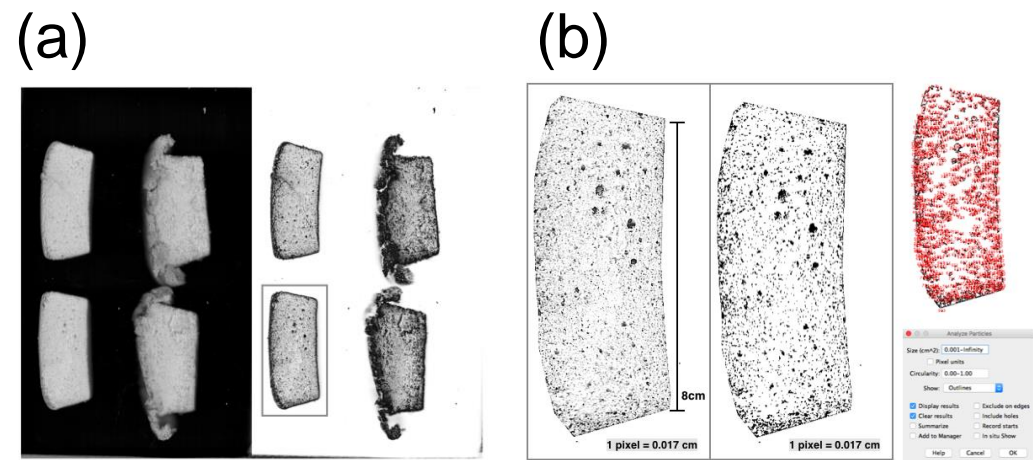


Fig 1. | Behavior of the batter under temperature influence

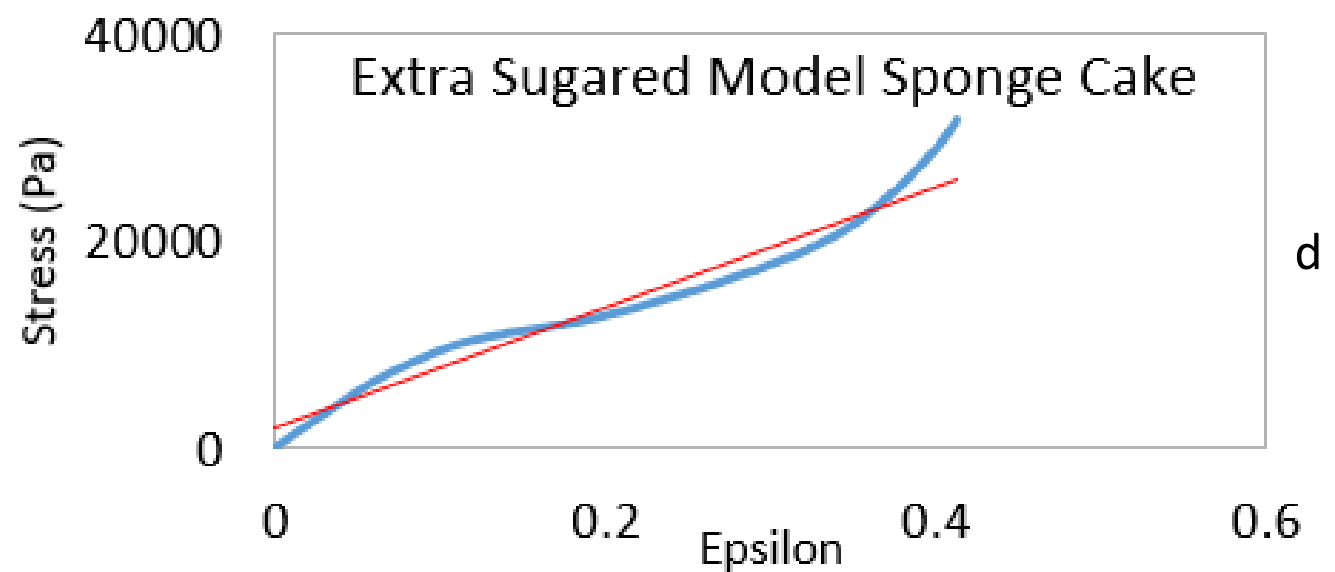
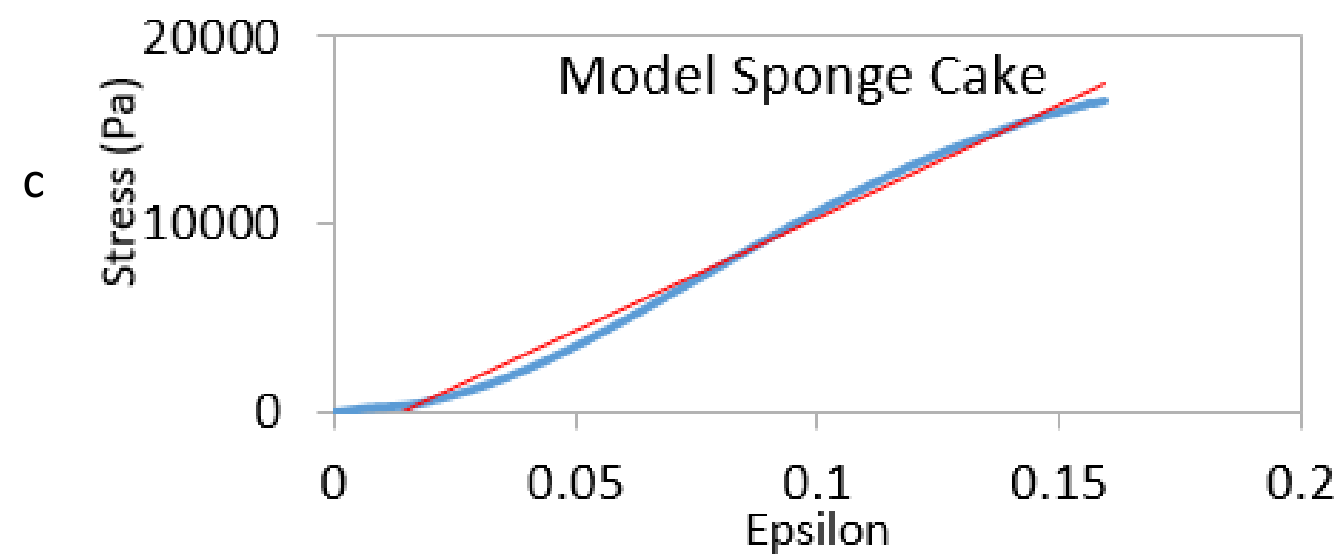
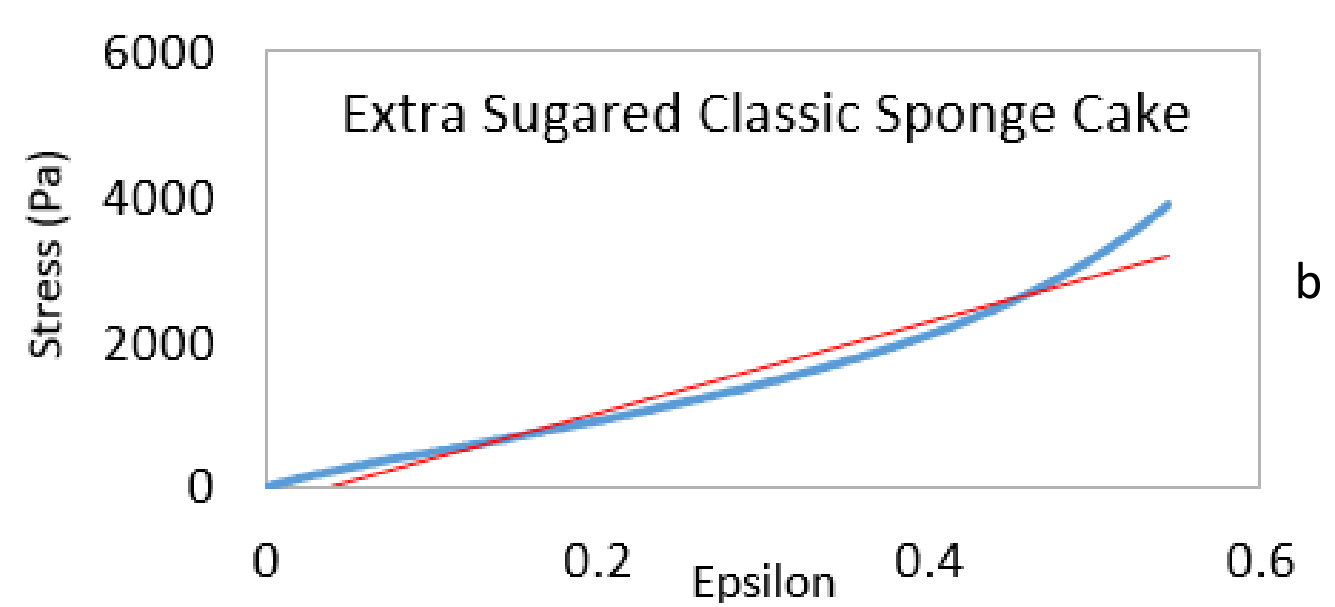
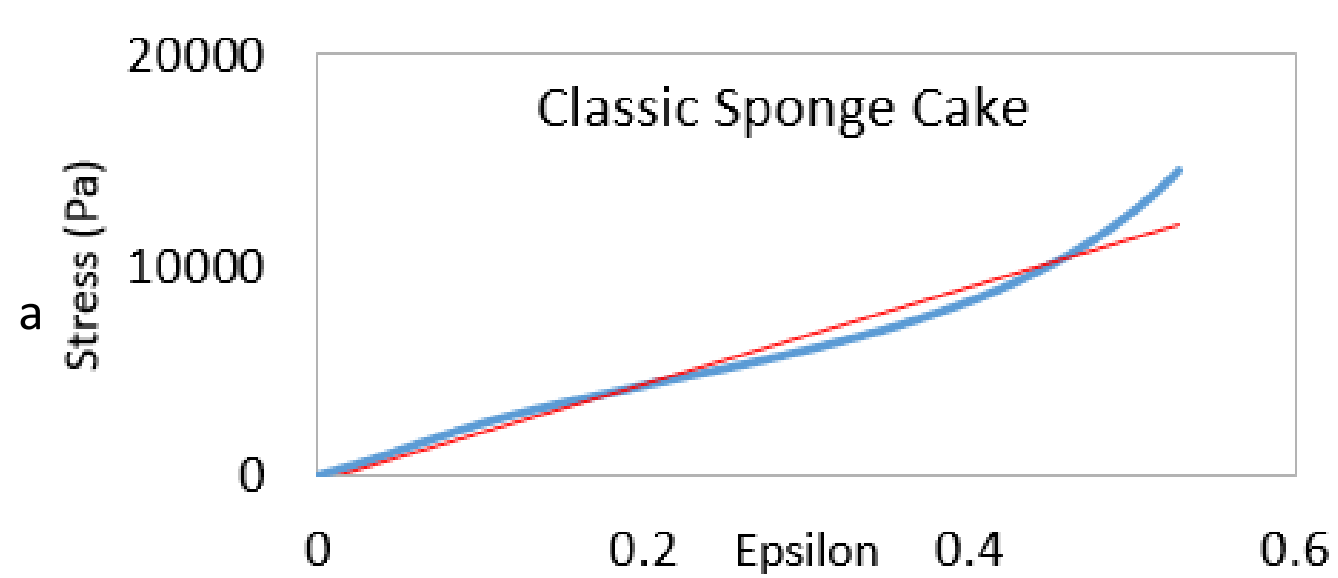
a. Behavior of a MC/HPMC solution. The ether cellulose polymers are composed of both hydrophilic and hydrophobic regions. Hydrophilic regions interact with water through H-bonds and hydrophobic regions are clustered in water cages allowing chain solubility. MC gels before HPMC. During gelatinization, the water cages melt and the chains of polymer bind through hydrophobic bonds. These bonds occur between highly substituted areas of polymer. This results in a 3D gel network with high viscosity. **b.** Starch+cellulose batter. When added to the water, starch swells by water absorption. When heated, some compounds like amylose are released from the granules and then make a gel network. The high viscosity is provided by this gel and the swelling of starch. **c.** Starch+cellulose+sugar batter. When sugar is added, the viscosity of the batter decreases compared to cellulose+starch batter. This can be interpreted by a less important swelling of starch. Sugar displaces water from starch granules by H-bonds between glucose units and water molecules and prevent them from hydrating correctly.

Figure 3: Optical characterisation of cake's inner structure and it's through the example of sugar's influence determination



All cakes were cooked using the same baking protocole we have been able to achieve

- (a) Cakes are being cut and placed on a scanner surface with a cardboard box on top in order to make the image (left). It is then retouched using photoshop in order to enhance contrast and sharpness (right - all samples are retouched with the same filers)
- (b) The images are exported on ImageJ where we first get rid of the crust (left) in order to use the Analyze particule process : black alveoli should not be mistaken with the crust. Before using Analyze Particule, the image is converted into Binary (middle). On the right are shown Analyze particule settings (down), the minimum size used is 0.001 cm² due to scanner resolution : 1 pixel = 0.017cm; we are thus sure to sample every visitle alveolus without it taking too long. On the upper right is shown the outlining of Analyze Particule.
- (c) Data obtained from Analyze Particule are exported on excel then treated with a Matlab program we designed. Histograms of alveolar radius are plot for different sugar percentages. The distribution shape seems to be slightly the same for all sugar concentrations, only radius values differ. Regarding the most frequent radius : (0% sugar - $r=0.0179\text{cm}$) | (14% sugar - $r=0.0179\text{cm}$) | (24.5% sugar - $r=0.0096\text{cm}$) | (39.4% sugar - $r=0.101\text{cm}$). Plus, it has been seen during the experiments that the more sugar there is the less compact is the structure: the 39.4% sugar cake collapsed easily.
- (d) Histograms data were treated in order to suppress zero values of N (number of alveoli with a radius equal to r). We conducted the experiment on 10 cakes for each sugar percentage and eventually plotted the averages on the graph. Though fluctuations of the most frequent radius can be seen, it seems that the more sugar there is the less large this radius tends to be. However, we haven't really been able to formulate a real conclusion on the evolution of the alveolar radius with sugar concentration.



e

Sponge Cake	Young Modulus (Pa)
Classic Cake	23 030
Extra Sugared Classic Cake	6 260
Model Cake	120 033
Extra Sugared Model Cake	58 482

a) to d) The graphs from these figures correspond to the compression tests performed on the cakes. The tests were realized with Blue Hill Traction Machine in compression mode and the graphs were plotted in Excel using the raw data acquired by the Blue Hill software. The classic sponge cake is baked following a traditional sponge cake recipe. The extra sugared classic cake contains 3 times the amount of sugar of the classic cake. The model sponge cake is cellulose based with no sugar and conceived to mimic a classic cake structure. The extra sugared

model cake is a model cake containing the same amount of sugar as the extra sugared classic cake.

e) The table showing the Young Moduli for the different cakes. The Young Modulus of the model cakes is substantially lower than the one of the classic cakes and the sugared cakes have Young Moduli several times lower than their sugar-free counterparts.