ABE 303 – Applications of Physical Chemistry to Biological Processes
Homework 1 – Fall 2017 (100 marks)
Deadline Thursday September 7

Problem 1. You were given definitions of different types of porosity used to characterize biomaterials. These porosities are calculated from different types of density that are suitable to characterize porous and non-porous biomaterials. By using the basic definitions of those densities prove that the definitions of the following porosities are correct:

$$\varepsilon_B = 1 - \frac{\rho_B}{\rho_{part}}$$

$$\varepsilon_{cp} = 1 - \frac{\rho_{part}}{\rho_s}$$

[20 marks]

Problem 2. Calculate the true density of spinach leaves at 20°C. For details of spinach composition, you could use tables provided in lectures or the US Department of Agriculture (USDA) Database.

[20 marks]

Problem 3. A berry fruit has a moisture content of 80% (wb). The apparent and bulk densities are 605kg/m^3 and 500 kg/m^3 at 25°C, respectively. Assuming the berry contains only carbohydrate and water calculate the total porosity of these berries when they are stacked in bulk.

[20 marks]

Problem 4. The composition by weight of a biomaterial, which is non-porous, is the following:
Protein: 18.0%
Carbohydrate: 4.0%
Ash: 0.5%
Fat: 2.5 %
Water: 75.0%
All composition are expressed in wet basis.
(a) What is the moisture of the biomaterial before drying expressed on a dry basis?
(b) If the biomaterial is dried to 40% moisture content (wet basis) without any shrinkage, what will be the apparent density and the apparent porosity of the dried material?
(c) Briefly explain why the biomaterial becomes porous after drying.

[40 marks]