Foam Stability Properties of Food Ingredients

Reference: LE Bennett, S. Sudharmarajan, K.J. De Silva, J.L. Barnett, M.A. Johnson, R. Stockmann and G.W Smithers
Food Science Australia, Highett, Victoria 3190 Australia.

Introduction

The foaming and emulsifying characteristics of proteins are important attributes during the production stage, storage, transport, and consumer perception of quality (appearance) of food dispersions (emulsions and foams). In this contribution, we are concerned with the analysis of foaming, and emulsifying characteristics of different protein

Methods for measuring properties such as foam and emulsion stability are usually empirical and not sensitive enough to differentiate different proteins.

In this application note, the foam stability of different food ingredients containing protein have been investigated in collaboration with the ***Food Science Australia*** using the Turbiscan™ technology.

Reminder on the technique

Turbiscan® technology, based on Static Multiple Light Scattering, consists on sending a light source (880nm) on a sample and acquiring backscattered (BS) and transmitted (T) signal all over the sample height. By repeating this measurement over time at adapted frequency, the instrument enables to monitor physical stability.

The signal is directly linked to the particle concentration (φ) and size (d) according to the Mie theory knowing refractive index of continuous (n_f) and dispersed phase (n_p):

$$BS = f(\varphi, d, n_p, n_f)$$

Method

Different food ingredients containing proteins have been investigated to evaluate their foaming properties. Three proteins have been selected from commercial source:

- Total milk protein (**TMP**, TP=83.4%)
- Whey protein concentrate (**WPC**, TP=70.5%)
- Egg white powder (**EWP**, TP=75.8%)

And three proteins have been prepared in pilot facilities at Food Science Australia:

- Skimmed milk powder (**SMP**, TP=75.8%)
- caseinate (**CAS** , TP=75.2%)
- β-lactoglobulin-enriched protein powder (**BF**, TP=78.8%)

The True protein percentage was determined by the difference between Kjeldahl total and non-protein nitrogen.

Foams were prepared using a blender (Braun) with whisk attachment, after dissolution of 100 mg/g of true protein. Foams are then characterized using the Turbiscan by scanning them every minute during a period of 10 minutes.

Results

1. Raw data

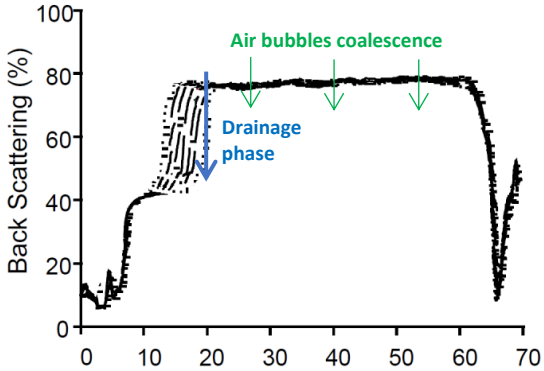

Figure 1: Backscattering intensity versus sample height

The stability of the foams is very easily visualized by looking at the raw data in backscattering (Figure 1). At the bottom of the sample an important decrease of the intensity of backscattering is observed due to the drainage of a liquid. Moreover all over the height of the sample a global decrease is measured meaning an increase of the air bubbles size.

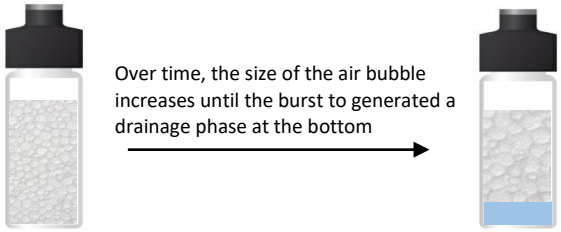

Figure 2: Schema of the destabilization

2. Kinetics of bubbles coalescence

By measuring the variation of the intensity of the light in the middle of the sample over the duration of the analysis, the kinetics of coalescence of the air bubble can be computed and compared between samples. Figure 3 shows the variation of backscattering over time due to the coalescence for sample SMP.

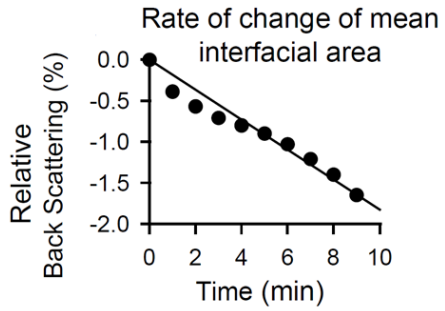

Figure 3: Backscattering variation over time for samples SMP

From the graph in Figure 3, the slope of the change is computed in order to get the kinetics of bubbles coalescence. All the values are reported in Table 1.

3. Kinetics of foam breakdown

In order to compare the rate of the liquid drainage at the bottom of the sample due to the foam breakdown over time, from the Figure 1, the first scan is used as reference, and the following graph is obtained (zoom on the liquid drainage phase)

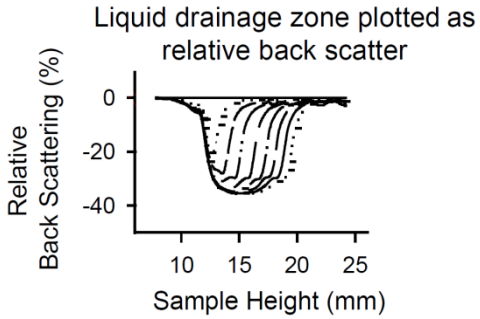

Figure 4: Delta backscattering for samples SMP

From the raw data can be calculated the **T**urbiscan **S**tability **I**ndex (**TSI)**, an automatic computation of the global stability who sums all the variation. At a given time, the higher is the TSI, the worse is the stability of the sample. Figure 5 gives the TSI for sample SMP. The slope is computed to characterize the kinetics of the drainage. All the values are reported in Table1.

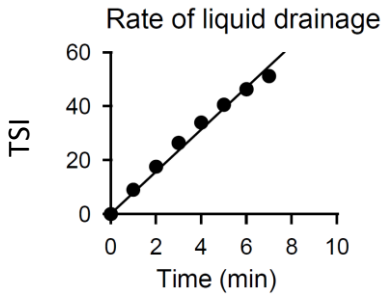

Figure 5: TSI versus time for sample SMP

Sample	Kinetics of coalescence (%/min)	Kinetics of foam drainage
SMP	0.19	6.5
TMP	1.40	1.56
WPC	Rapid foam collapse	21.2
EWP	0.34	0.78
CAS	No foam	No foam
BF	0.78	5.2

Table 1: Characterization kinetics for all samples

From the Table 1, we can conclude:

- Protein CAS does not generate foam,
- Protein WPC generates the less stable foam,
- Regarding the kinetics of coalescence the proteins can be ranked as follow from the least to the most stable:
  CAS < WPC < TMP < BF < EWP < SMP
- Regarding the kinetics of foam drainage, the protein can be rank as follow from the least to the most stable:
  CAS < WPC < SMP < BF < TMP < EWP

CONCLUSION

In this application note, different foams generated from food ingredient systems have been characterized using the Turbiscan™ technology and that within 10 minutes of measurement. The kinetics of coalescence as well as the kinetics of the liquid drainage formation has been computed and compared.