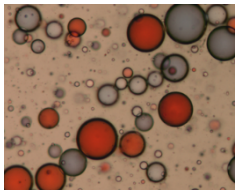

EVALUATION OF PLANT PROTEINS EFFICIENCY AS EMULSIFIERS IN FOOD

INTRODUCTION

There are attempts to valorize plant proteins (and particularly pea protein) against animal proteins. The share of plant proteins used in food ingredients is only 30%, and Europe imports 70% of its protein needs. Plant proteins are really an alternative for future generations for several reasons: decrease dependency on imports, require 8 times less fossil energy to be produced, and diversification, as market is monopolized by soybean.

Protein emulsifiers can act as surface active agents and are widely used in food, cosmetic and biomaterials industries. Pea protein tends to replace gluten as a stabilizer in snacks and now reduce market exposure to fluctuating egg costs as an egg replacement in baked goods and pastas. Pea protein price is twice lower than milk protein but still higher than soybean's.

In this application note, we propose to evaluate the performance in terms of emulsifying properties of a pea protein compared to a reference sodium caseinate in an o/w model emulsion. We propose to use a technique based on Static Multiple Light Scattering to determine two crucial parameters: initial size droplet in the bulk, and physical stability.

MATERIAL & METHOD

The efficiency of pea protein and sodium caseinate is assessed with a quick and simple protocol:

- Protein powder is first dispersed in phosphate buffer (0.01M, pH 7.4). Pea protein isolate (91% of protein DB) was provided by IMPROVE (France) and sodium caseinate by Ingredia (France).
- Pre-emulsification is done with: 20% wt sunflower oil, protein dispersion (different concentrations 1%, 0.5%, 0.25%, 0.1%), sodium azide (0.02%) and homogenized with high shear homogenizer Ultra-Turrax (IKA T25) during 4 minutes at 8000 rpm.
- Pre-mix is then sonicated during 10 minutes using an ultrasonic processor Vibra-cell 75042 (Bioblocks Scientific) with its 6 mm diameter stainless steel probe set-up at 30% of power (5 sec on, 5 sec off). The sample is placed in an ice bath to avoid heating during sonication.

Measurement with Turbiscan

Turbiscan is based on SMLS technology (Static Multiple Light Scattering) at 880nm, and enables to measure directly from the signal (BS, for Backscattering signal) the mean spherical equivalent diameter (d), knowing refractive index of continuous (n_f) and dispersed phase (n_p) and the particles concentration (φ) according to the Mie theory:

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

By monitoring the samples versus time, Turbiscan also enables to compare samples in terms of physical stability.

RESULTS

Mean spherical equivalent diameter

The graph displayed in Figure 1 shows **the mean oil droplet diameter for fresh emulsions** versus protein concentration in the initial aqueous phase, for the emulsions obtained with pea protein and sodium caseinate.

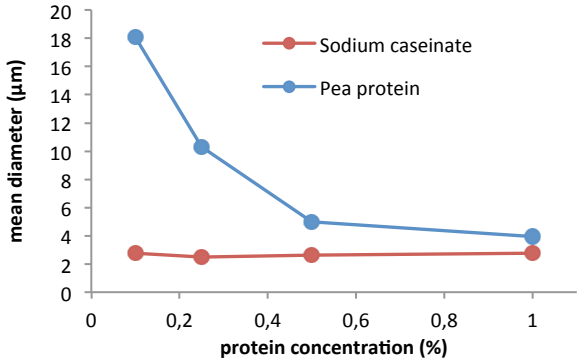

Figure 1: Mean droplet diameter for emulsions with pea or sodium caseinate versus protein concentration

This graph shows that pea protein forms emulsions with larger droplet diameter than sodium caseinate, even if 1% pea protein enables to reach a diameter in the same range as sodium caseinate. Even at the lowest concentrations, sodium caseinate enables to reach a low diameter, showing that pea protein has a lower emulsifying activity than sodium caseinate.

Global Stability

✓ ***Identification of destabilization phenomena***

The following graph displays the delta-backscattering signal for one of the emulsions. All emulsions evolve with the same mechanisms.

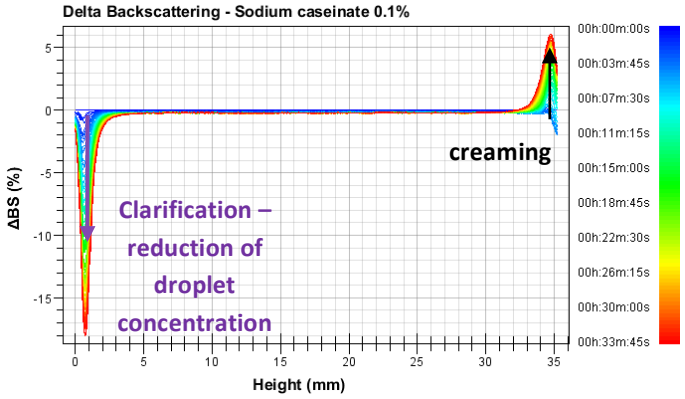

Figure 2: Delta-BS signal for emulsion with 0.1% sodium caseinate

The Turbiscan profile displays a decrease of signal at the bottom of the sample (left part of the graph) and an increase at the top of the sample (right part of the graph). It means that the concentration of scatterers is decreasing at the bottom and increasing at the top of the sample. In other words, phase separation is occurring in the sample, with formation of a clarified layer at the bottom and a cream phase at the top.

✓ ***Global stability kinetics***

In order to assess global stability, all the destabilizations occurring in the sample have to be taken into account. The Turbiscan Stability Index (TSI) was created in this purpose, it sums up all the variations over the whole height of the sample. As a result, if the signal evolves a lot, the TSI will be high; therefore, the higher the TSI, the lower the stability.

The Figure 3 shows the TSI after 20 minutes of destabilization for emulsions obtained with pea protein and sodium caseinate at different concentrations. It can be seen that increasing pea protein concentration enables to increase emulsion stability. It shows also that emulsions with sodium caseinate stability is independent of protein concentration.

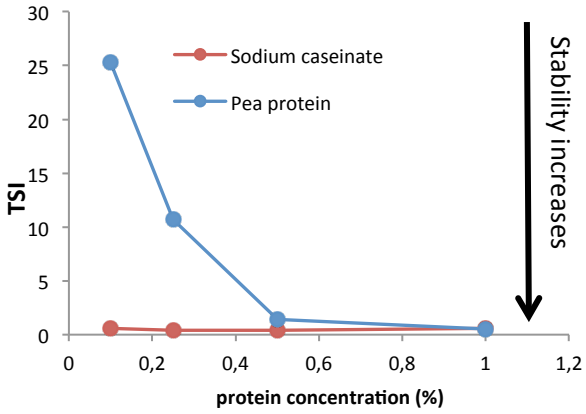

Figure 3: Turbiscan Stability Index (TSI) after 20 minutes for emulsions with pea or sodium caseinate versus protein concentration

✓ ***Protein efficiency***

The Figure 4 is a summary chart ***(the smaller the area, the higher the efficiency)***, showing that pea protein enables to reach stability close to caseinate but at larger concentrations. It shows also that the larger the droplet size, the lower the stability.

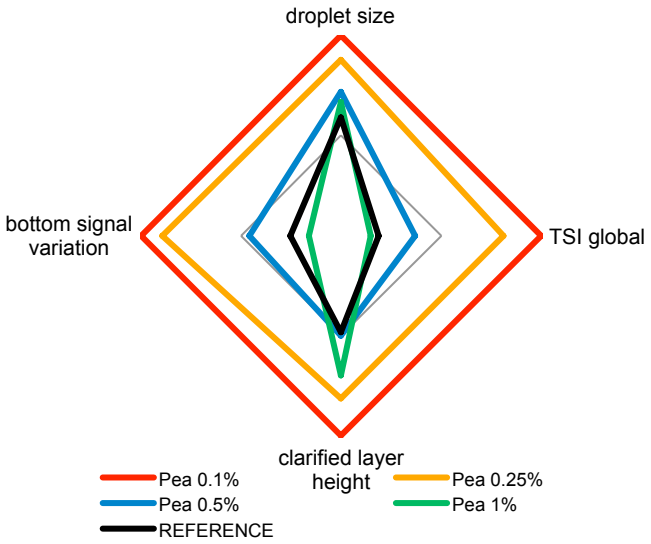

Figure 4: Summary of all the results obtained with Turbiscan

SUMMARY

Turbiscan technology based on Static Multiple Light Scattering enables to measure mean size in a large range of concentration between 0.0001 and 95%, for sizes between 10 nm and 1000 µm. This technique has the advantage to measure the mean particles size in one-click, without sample preparation or dilution, particularly for concentrated dispersions, and to quantify samples stability at the same time, by identifying and quantifying destabilization phenomena.