TURBISCAN DNS

FOOD : Plant Protein Integration
Solubilization

INTRODUCTION

Plant-based protein use has been expanding over the past years and offers numerous advantages: sustainable origins, vegan alternative, cost effective and health benefits. Proteins obtained from sustainable sources do not have the same performances as conventional emulsifiers. With an increasing offer, selecting the right protein can represent a bottleneck in new product development. Impacting many other properties (emulsifying, foaming...), protein solubility is essential to develop food formulations matching the current standards.

This paper shows TURBISCAN DNS capabilities to study and optimize plant based protein solubility.

Plant protein **Solubility** **Online**

FORMULATING WITH PLANT PROTEINS

Removing or partially replacing traditional emulsifiers with plant based proteins can be very complex : protein selection (including its origin), possible functionalization, optimum concentration... Three parameters must be considered : protein solubility, protein emulsifying and stabilizing properties.
Several methods are available to characterize* proteins' functional properties but they usually request several instruments, multiple tedious experiments and sample preparation. Turbiscan technology offers a complete solution to study all these properties with only one device and for fast decision making.

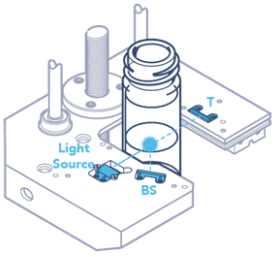
In this note, two plant proteins' solubility will be tested online using the TURBISCAN DNS functionalities. Emulsifying and stabilization properties are covered in a separate application note.

* *McClements et al, Proposed methods for testing and comparing the emulsifying properties of proteins from animal, plant and alternative sources.*

TURBISCAN®: HOW IT WORKS

Turbiscan® technology, based on Static Multiple light scattering (SMLS), consists of illuminating a sample with an infrared light source and acquiring Backscattered (BS) and Transmitted (T) signals.

BS and T = f(φ, d, np, nf)



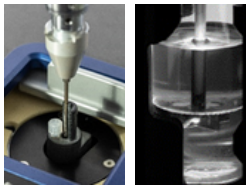
φ: particle concentration
d: particle diameter
np: dispersed phase refractive index
nf: continuous phase refracrive index

The signal is directly linked to particle's concentration (**φ**) and size (**d**) according to the Mie Theory, with (**nf**) and (**np**) being fixed parameters. Measurement of BS and T can be performed either on scanning mode, to provide homogeneity and stability measurement, or with very high frequency for high frequency resolution and online measurement. Measurements are performed without any dilution & on native sample up to 95% V/V and from 10nm up to 1mm.

The **Turbiscan® DNS** for **Dispersibility** and **Stability** is composed of 2 modules:

- **T-MIX** for automated fast formulation screening, particle dispersibility studies with a stirring bar directly adapted inside the measurement cell.
- **T-LOOP** for online measurements and scale up/ process optimizations with an integrated peristatic pump. The formulation is pumped from the reactor in and out the measurement cell, creating a circulation loop.

Turbiscan® DNS



T-MIX Module

Figure 1. Turbiscan DNS with a focus on the T-MIX Module

Plant proteins solubility with Turbiscan®

Solubility properties of two plant-based proteins (pea and soy) are studied at 25°C, pH=7. First, 15 ml of distilled water is added into a measurement cell. The stirring blade height is fixed between 22 and 26 mm of the total vial height.
Once 1.15 g* of protein powder was added, the backscattering value was recorded each 1s over 45 minutes at fixed position (15mm) while mixing at 300rpm.
**recommended dosage for this powder*

Food - Plant Protein Integration Solubilization

The following illustration shows the measurement principle : SMLS technology combined with the TMIX online study.

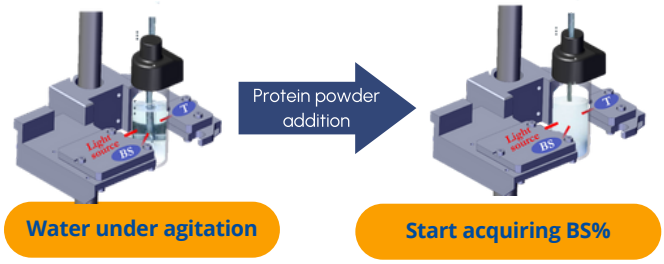


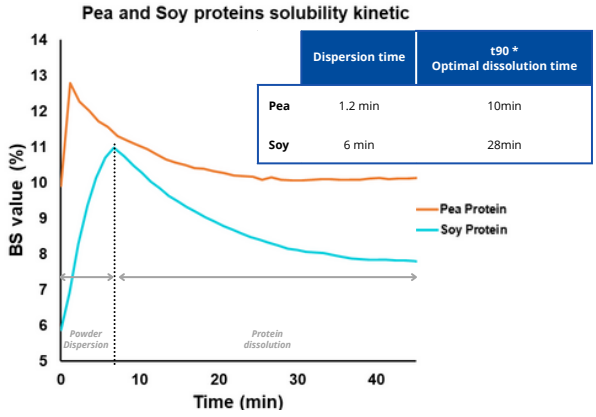
Figure 2. Illustration of SMLS technology combined with T-MIX module

As backscattering value is directly related to particle concentration and size, its evolution over time is directly linked to the dispersibility state and hence protein solubility.

RESULTS

Powder dispersibility and protein solubilization kinetics

The graph bellow displays the evolution of backscattering value as a function of solubilization time.



	Dispersion time	t90 * Optimal dissolution time
Pea	1.2 min	10min
Soy	6 min	28min

Figure 3. Soy and Pea protein solubility in function of time and under mixing condition

**t90 corresponds to the time to reach 90% of the final value*

For both preparations, a two-step kinetic is observed :

- Powder de-agglomeration : First and right after powder addition, an increase of backscattering value is observed. This increase corresponds to the powder dispersion into water. Backscattering increases due to powder de-agglomeration leading to a decrease of particle size.
- Protein dissolution : After the de-agglomeration step, backscattering decreases due to protein solubilization (hence less scatterers).

Difference between Pea protein or Soy protein ?

Pea protein powder displays a much faster powder de-agglomeration. Furthermore, the optimum solubility is obtained after only 20 minutes (plateau value of backscattering), while it takes a least twice longer for soy protein (40 minutes).
However, soy protein may need to be mixed for a longer time as the backscattering drop is more important compare to pea protein. This could result a higher solubilization property in the end.

How to boost protein solubility ?

Multiple parameters have an impact on protein solubility (temperature, ionic strength, pH...). In this paper, the impact of sodium chloride (NaCl) on pea protein solubility was investigated.

Two solutions with sodium chloride (NaCl) at different concentrations were prepared (1 mol/L and 0.5 mol/L).
Sodium chloride was first added to 15ml distilled water and and a similar protocol to that of the previous experiment was applied.

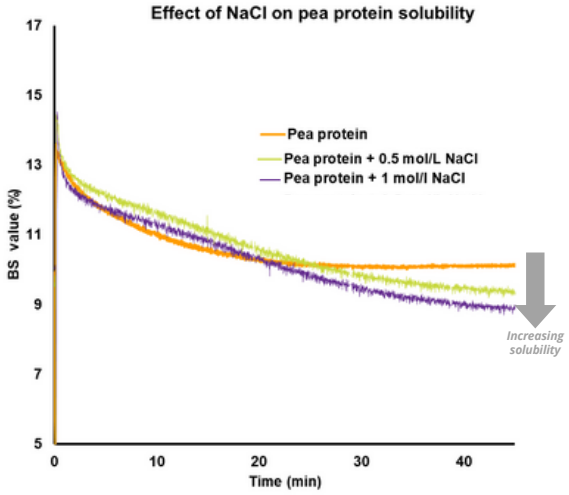


Figure 4. Pea protein solubility kinetics at different NaCl conc. and under mixing condition

Impact of NaCl concentration on pea protein solubilization :

- Dispersion step : NaCl addition does not show an impact on powder dispersion. After less than 2 minutes the powder de-agglomeration is completed.

- Solubilization step : The impact of NaCl addition on pea protein solubilization is observed after 20 minutes: it helps to solubilize residual proteins in suspension, with a lower final backscattering value after 40 minutes.

To summarize, addition of salt (NaCl) has a significant impact on final solubility of pea protein. However, it does not impact its solubilization speed and requires mixing for 40 minutes to reach the optimum solubilization rate.

CONCLUSION

Thanks to online and high frequency measurement, protein solubilization kinetics is precisely monitored in a single and straigtforward experiment.
Turbiscan DNS is the perfect platform to study, compare and optimize plant protein solubility.

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