Formulaction Smart scientific analysis | TARUKINO | TURBISCAN LAB

Precise Shelf Life Determination of THC-Infused Beverages

- In collaboration with Tarukino, LLC, Seattle, WA, USA -

FOOD & BEVERAGES

Introduction

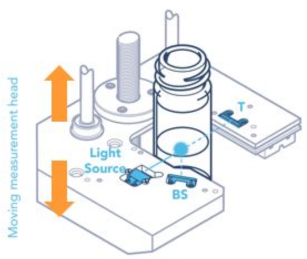
The fast-paced and growing market of THC- and CBD-infused beverages provides several challenges for a formulator. Aside from working in an entirely new market with new materials, guidelines are not yet in place to monitor and regulate the potency of such beverages as they age – the destabilization of the oil inside of the beverage can create zones where the dosage is higher than in other regions. Chromatographic techniques require an invasive process to quantify this stability. Here, we will show how the Static Multiple Light Scattering technique utilized in the Turbiscan device can be used to quantify the volume fraction evolution of a destabilizing THC-infused emulsion and letdown beverage.

KEY BENEFITS

- ACCURATE
- NO DILUTION
- VERSATILE

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 over the whole sample height. By repeating this measurement over time with adapted frequency, the instrument enables to monitor physical stability.
The signal is directly linked to the particle concentration (ϕ) and size (d_{SMLS}) by the Mie theory knowing refractive index of continuous (n_f) and dispersed phase (n_p):



$$BS = f\ (\phi,\ d_{SMLS},\ n_p,\ n_f\ )$$

Materials & Method

A single THC-infused emulsion product was analyzed with the Turbiscan at temperatures of 3, 25, and 40 °C over a period of nearly 200 days. The data is then analyzed to quantify a local volume fraction of the THC-infused oil content in the clarification layer occurring at the bottom of the sample vial.

Particle size analysis of the oil droplets was also monitored and seen to be consistent at 1.33 µm, on average, throughout the evolution of the sample.

Results

Raw data

The fluid, opaque samples remained free of any visual phase separation for the entire 200-day experiment. The change in the backscattering signal (ΔBS) still provides insight into the kinetics associated with particle migration away from the zone at the bottom of the sample.

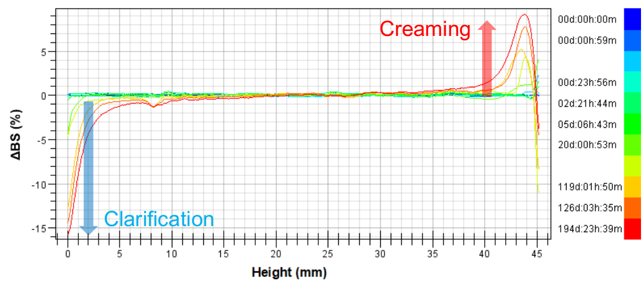


Figure1: Delta of Backscattering at RT of a THC-infused emulsion

At the top of the sample (right portion of the graph) the positive evolution of the backscattering signal can be observed. This indicates that particles are migrating towards this zone - a creaming phenomenon is seen.
Likewise, the negative evolution of the sample at the bottom of the sample (left of the graph) is an indication of oil droplets migrating away from this region.

It is important to note that particle size change (flocculation), usually detected as the global signal in the middle of the sample, is not observed in this case. Particle/ Droplet size is not evolving.

Volume fraction kinetics

As the intensity of light scattering decreases at the bottom of the sample, it is indicative that there are oil particles migrating away from this zone.
Since the particle size is known and does not change throughout the experiment, the percentage of active oil mixture can be calculated at the bottom of the vial.

Figure 2 displays the kinetic plot for the THC-infused emulsion concentrate at three different temperatures.

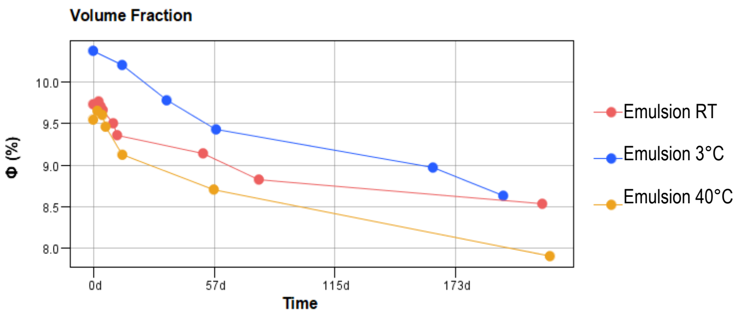


Figure 2: Volume fraction kinetics for all samples

The initial values for volume fraction can vary from the measured 10% loading, as different temperatures can affect the raw scattering values. But, the evolution of the plots clearly shows the extent at which the samples are destabilizing.
To quantify this phenomenon a delta (final - initial) is calculated. All values are displayed in Table 1.

Sample	Φ (initial)	Φ (final)	ΔΦ @ ~200 d
Emulsion, RT	9.73%	8.53%	**-1.20%**
Emulsion, 3 °C	10.37%	8.63%	**-1.74%**
Emulsion, 40°C	9.54%	7.90%	**-1.64%**

Table 1. Volume fraction values during emulsion ageing.

The emulsion oil concentration at the bottom of the vial will be decreased anywhere from 1.2-1.7% over the approximate 200-day trial.

A diluted emulsion was also analyzed at 25°C for shelf stability over time in order to showcase the utility of a typical letdown consumption beverage. We can see this in Figure 3 that there is minimal evolution of this sample, changing just 0.02% over 210 days (0.43% to 0.41%).

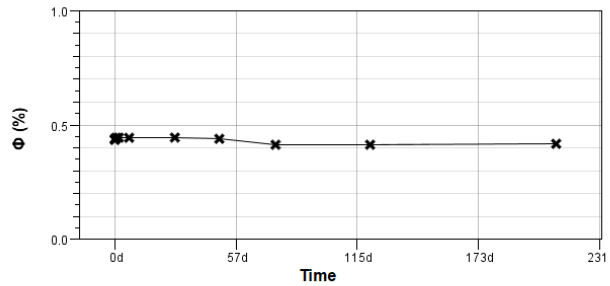


Figure 3. Volume fraction kinetics for a let-down sample

Quantifying destabilization with the TSI

The TSI algorithm incorporates all phase separation kinetics (creaming, clarification) in order to provide a quick, global ranking of sample stability. Figure 4 provides the TSI plot for all samples.

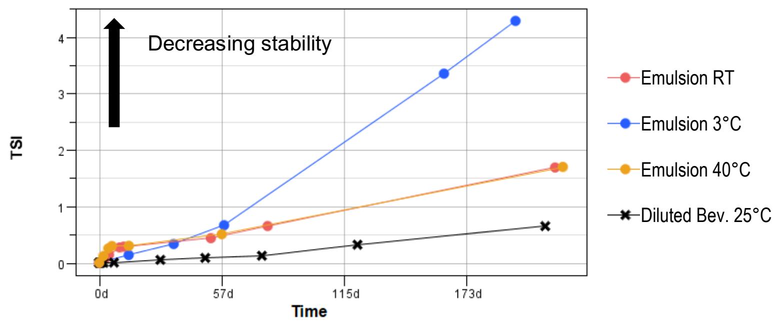


Figure 4. Turbiscan Stability Index (TSI) for all samples.

All samples reveal excellent stability (TSI<5) when measured around 200 days with no visual phase separation detected. This, along with the previous volume fraction kinetics, provides concrete proof of the high stability of these samples over varying temperature and concentration ranges.

CONCLUSION

A passive, non-destructive method is described to analyze and predict the stability of THC-infused beverage samples at varying concentration and temperature ranges. This allows for quantification of the THC-based oils present in a sample in order to detect any potency variations throughout a sample as it ages. This can therefore eliminate and errors or inconsistencies that develop with other invasive measurement techniques.