

Droplet Size Analysis of Mayonnaise

AccuSizer® SPOS System

Mayonnaise is a thick, creamy condiment that is a stable emulsion of oil, egg yolk, and either vinegar or lemon juice, with many options using various herbs and spices. Like any other emulsion, the droplet size plays an important role in stability. Formulators creating new types of mayonnaise (or mayo type spreads) may wish to analyze the oil droplet size to optimize new recipes for maximum shelf life. The AccuSizer® is an ideal analytical instrument for studying new formulations, to accurately define droplet size distribution and concentration.

INTRODUCTION

In the US, the FDA has stated that mayonnaise must contain not less than 65% by weight of vegetable oil, acidifying ingredients (such as vinegar or lemon juice), egg yolk containing ingredients, and other optional ingredients (such as salt, spice, sequestrants).¹ Similar condiments not meeting these requirements are typically labeled “mayo” or “spread”. Many similar but modified condiments are now entering the market with different oils, and other formula changes, to appeal to specific target consumers. Testing the droplet size, and other chemical/physical properties, are common when formulating new mayonnaise type products.

ACCUSIZER

The AccuSizer is an advanced liquid particle counter/particle size analyzer used for a variety of applications, including food product formulation. The sensor can be used solely in light extinction mode, or as a combination of extinction plus scattering in order to measure smaller sizes down to 0.5 μm . Pulses from the sensor are sent to a pulse height analyzer (counter) that converts pulses to particle size through the use of a calibration curve. A sampler containing autodilution fluidics such as the AccuSizer AD (Figure 1) is often used to dilute the sample to the optimum concentration for accurate measurements. The AccuSizer AD uses single-stage exponential dilution



to automatically dilute the sample while still being able to accurately determine concentration in particles/mL. The AccuSizer software controls the measurement sequence, instrument maintenance, and result reporting. Results can be reported in many formats² including:

- Particles/mL vs. size
- Percentage area or volume distribution vs. size
- Absolute volume

The AccuSizer is the most sensitive particle analyzer available for detecting tails of distributions. This is important in food emulsions, because a tail of larger droplets is often an indicator of poor emulsion stability.³



Figure 1. AccuSizer A7000 AD

SAMPLES ANALYZED

Four commercial mayonnaise type products were bought locally:

1. Real mayonnaise
2. Light mayonnaise
3. Avocado oil mayo
4. Vegan spread

SAMPLE PREPARATION

The samples were prepared by first prediluting and dispersing in DI water. The sample was then injected into the AccuSizer AD for analysis. The sample preparation procedure is defined below.

- 20 mL DI water was poured into a clean vial
- 0.02 g of sample was added to the vial
- The vial was dispersed using a vortex mixer for 30 seconds
- 20 μL of prediluted sample was injected into the AccuSizer AD with a 60 mL dilution chamber

Note: Measuring the 0.02 g sample was the most challenging part of the sample preparation and the accuracy of this step was not validated.

INSTRUMENT SETTINGS (PROTOCOL)

The AccuSizer AD settings used for the measurements are shown below:

- Measurement mode: Single stage dilution, manual injection
- Sample volume: 0.02 mL
- Sample run time: 60 sec
- Background concentration: 500/mL
- Baseline offset: 2
- Equilibration volume: 2 mL
- Number of channels: 512
- Sensor mode: Summation
- Threshold: 0.56 μm
- Stirrer speed: 40%
- Target concentration: 3500/mL

RESULTS

The AccuSizer can report results in many formats. The results shown below are plotted in volume % vs. size.

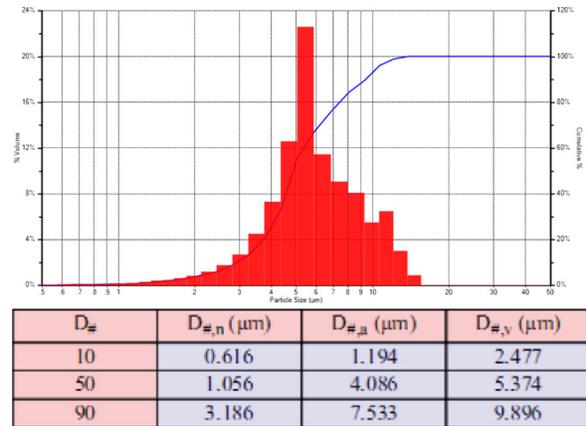


Figure 2. Real mayonnaise results

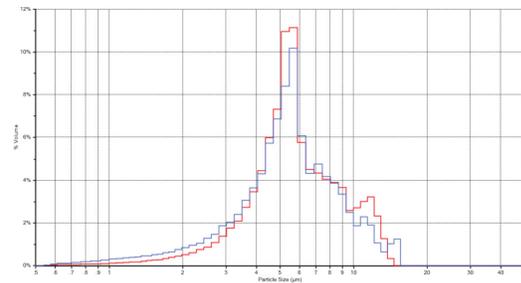


Figure 3. Overlay of two real mayonnaise results

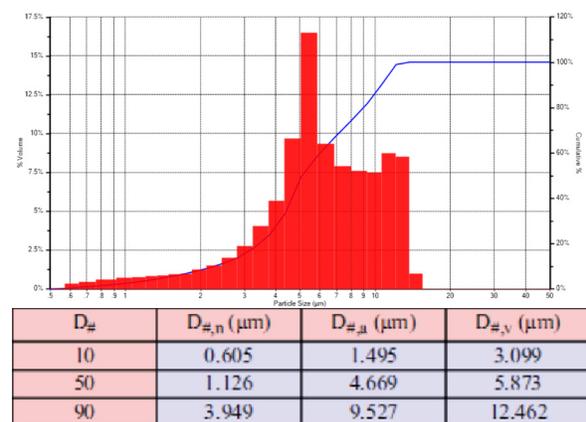


Figure 4. Light mayonnaise

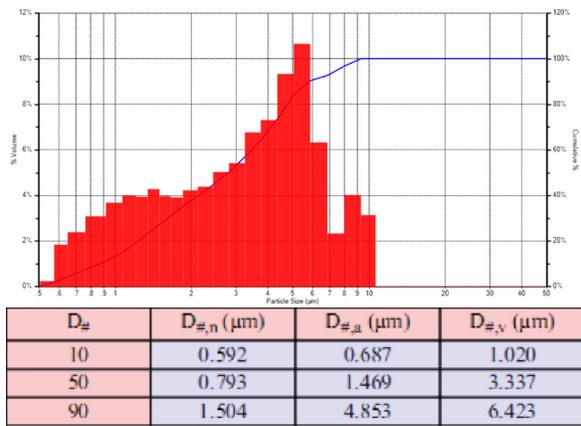


Figure 5. Avocado oil mayo

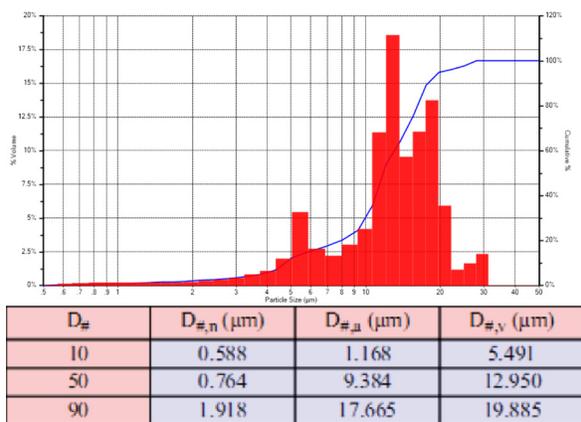


Figure 6. Vegan spread

QUANTITATIVE CALCULATIONS

The AccuSizer software can also provide quantitative result calculations such as volume fraction, ppm/ppb, and absolute volume. For this study the tabular results were exported into excel where calculations were made to determine the number of particles (droplets)/gram greater than specified sizes. The results shown in Figure 7 show cumulative number of particles/gram greater than 0.56 and 10 µm.

	>0.56 µm	>10 µm
Real	8.80E+10	1.74E+08
Light	4.86E+11	1.49E+09
Avocado	2.77E+12	0.00E+00
Vegan	1.01E+11	1.51E+09

Figure 7. Cumulative number of particles (droplets)/gram above given size

CONCLUSIONS

The AccuSizer A7000 AD was used to analyze a range of mayonnaise type samples. A summary of the D10, D50 and D90 results (volume basis) is shown in Figure 8. The dynamic range of 0.5 – 400 µm was more than adequate to fully characterize all samples. The autodilution system made sample analysis quick and easy, with total analysis time plus flushing around three minutes per sample. The high resolution results, concentration data, and volume fraction calculations provide significantly enhanced results compared to other techniques like laser diffraction.

	D10	D50	D90
Real	2.477	5.347	9.896
Light	3.099	5.873	12.462
Avocado	1.02	3.337	6.423
Vegan	5.491	12.95	19.885

Figure 8. Results summary

References

- ¹ FDA 21 CFR Part 169; "Food Dressings and Flavorings"
- ² Entegris Technical Note - AccuSizer Data Interpretation
- ³ Entegris Application Note - Emulsion Stability

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