HORIBA Scientific

Application Note

Mayonnaise
AN214

The classic ingredients of mayonnaise; oil, eggs, vinegar and salt, contain a high number of calories. In an effort to reduce the fat content, manufacturers have either reduced or substituted ingredients in an effort to appeal to a more health concious society. It is interesting to note that unless the product contains over 65% oil, The U. S. Federal Drug Adminístion rules that it cannot be called mayonnaise. In these cases, the product will be named either 'mayo' or 'dressing'. This application note reviews the important role that particle size plays in the formation of mayonnaise and mayo products and how changes affect the taste and consistancy of these alternatives.

Introduction

Mayonnaise is one of the most popular condiments world-wide and is prepared in many different ways. The basic method is an oil-in-water emulsion made with egg yolk, an acid such as vinegar and/or lemon juice, oil, and salt. Egg yolk is a key ingredient because of the high emulsifying capacity caused by the phospholipids and lipoproteins (LDL and HDL)[1]. Egg yolk also contributes 6mg of cholesterol to every tablespoon of mayonnaise[2]. By defintion, the oil accounts for 65% volume of mayonnaise[3]. This is equivalent to 10 mg of fat per tablespoon, or 100 of the 2000 daily recommended calorie intake. As health conscious consumers begin to scrutinize the ingredients on the Nutrition Facts Labels, there is growing pressure on manufacturers to create a mayonnaise product with lower cholesterol, lower calories, and healthier oil content but still maintains a consistent taste and the same mouth-feel as regular mayonnaise.

Physiochemical Properties of Mayonnaise and the Importance of Particle Size

There are seven physiochemical properties of mayonnaise which are key factors for determining consumers' acceptance of the product[4]:

1. Emulsion stability
2. Rheological properties (spreadability)
3. Sensory characteristics (taste, color, odor, consistency, texture, appearance, and overall acceptability)
4. Particle size distribution
5. pH
6. Cholesterol content
7. Microstructure

Creating the right balance of these factors is the challenge manufacturers face. As an example, removing egg from the mayonnaise formulation greatly reduces cholesterol content, but it also removes the key emulsifier that holds oil and water together. An appropriate egg mimicking emulsifier, such as soy protein isolate or pea protein, must be used to maintain emulsion stability. Soy or pea protein, however, performs poorly as a viscoelastic agent. Therefore, a thickening agent must be added to preserve the rheological properties. Extra virgin olive oil is considered healthier than commonly used canola or soybean oil, but the result is a lower consistency and firmness. To reconcile taste with customers' acceptance of the label, the most important factor is particle size distribution as it controls the emulsion stability, rheological behavior and sensory characteristics. Determining particle size during formulation and manufacturing are important factors to ensure the acceptance of healthier mayonnaise.

Materials and Methods

Four commercially available jars of mayonnaise were purchased and tested. (Two of which were egg-less vegan mayos.) The data were collected with the LA-960 laser diffraction particle size analyzer with the following analytical test method:

Refractive Index: 1.46 | Imaginary (absorption): 0.001i
Dispersant fluid – Deionized water
Pump speed – Gentle pump speed at 1-3 to avoid disruption of emulsions

Results and Discussion

To determine the optimal particle size range that mimics real mayonnaise, a generic egg-containing mayonnaise was purchase and tested. The analysis results of the generic real mayonnaise along with popular vegan mayo and avocado oil mayonnaise were then overlaid for comparison. The conclusion is that the ideal mean droplet size for mayonnaise, regardless of which ingredients were used, is in the range of 10-13 µm (Figure 1).

Results and Discussion

To determine the optimal particle size range that mimics real mayonnaise, a generic egg-containing mayonnaise was purchase and tested. The analysis results of the generic real mayonnaise along with popular vegan mayo and avocado oil mayonnaise were then overlaid for comparison. The conclusion is that the ideal mean droplet size for mayonnaise, regardless of which ingredients were used, is in the range of 10-13 µm (Figure 1).

“Popular” vegan mayo exhibits a single modal Gaussian distribution for the size of its oil droplets, whereas generic, store-brand vegan mayo displays a bi-modal distribution and particles with sizes that extend up to 800 µm (Figure 2). The mean size of generic vegan mayo is five times as large as that of the popular vegan mayonnaise. The presence of particles larger than 30 µm generally influences mouth feel negatively and often leads to shorter shelf life. The instrumental result is validated when two vegan mayos were mixed with water. Large lumps could be seen floating on top of the generic vegan mayonnaise, while none were observed with the store-brand vegan mayo (Figure 3).

This data is summarized in the table below. The “healthier” mayonnaise needs to have a mean particle size of about 11 µm.

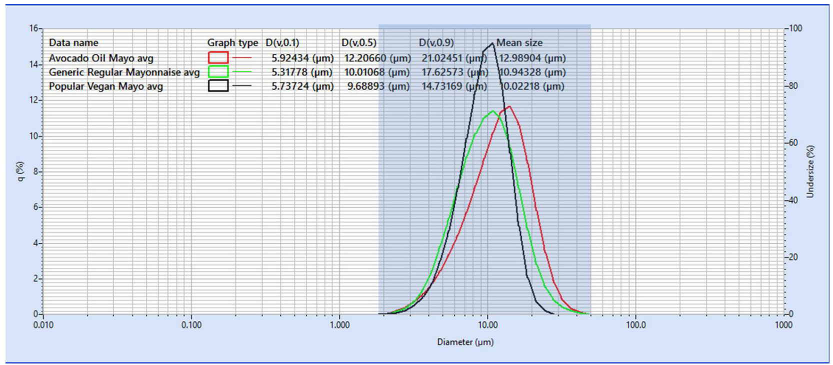

Figure 1. Optimized particle size range for various mayonnaise formulations

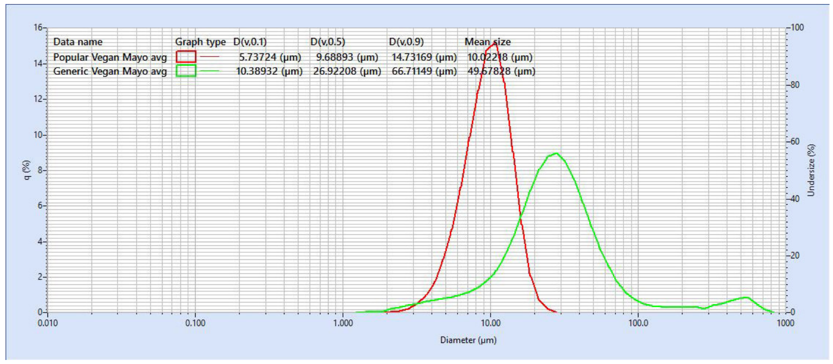

Figure 2. Particle size sets the difference between market-leading vegan mayo and those that are just mediocre, regardless of its ingredients

Data Name	Mean size	Number of peaks	Emulsion stability
Generic Regular Mayonnaise	10.94	1	Excellent
Avocado Oil Mayonnaise	12.99	1	Good - softer consistency
Popular Vegan Mayo	10.02	1	Good - similar to regular mayonnaise
Generic Vegan Mayo	49.68	2	Poor gelatin-like consistency with visible lumps

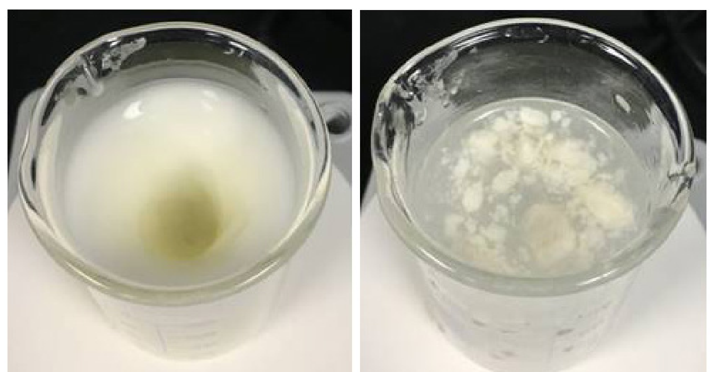

Figure 3. Dispersion of popular vegan mayo (left) and generic vegan mayo (right) in water

Summary

This study shows some examples of the effectiveness of the LA-960’s laser diffraction technique in determining the optimal particle size range for mayonnaise and, in particular, the importance of using particle size data to predict emulsion stability, rheological behavior, and sensory characteristics. Consumers today are willing to pay a premium price for a “healthier” innovative product if the particle size is preserved.

References

1. Ghazaei, Shiva, Maryam Mizani, Zahra Piravi-Vanak, and Mazdak Alimi. «Particle Size and Cholesterol Content of a Mayonnaise Formulated by OSA-modified Potato Starch.» Food Science and Technology (Campinas) Food Sci. Technol (Campinas) 35.1 (2015): 150-56.

2. https://en.wikipedia.org/wiki/Mayonnaise

3. FDA 21 CFR 169.140©

4. Carla Di Mattiaa*, Federica Balestrab, Maria Martuscellia, Lucia Andricha, Dino Mastrocolaa and Paola Pittiaa. Physical Properties, Microstructure and Stability of Extra- Virgin Olive Oil Based Mayonnaise. (n.d.): InsideFood Symposium. 9 Apr. 2013. Web. 26 July 2016.