Particle Sizing of Coffee Grounds

Coffee plays an important role in people's daily life. To brew coffee, ground coffee beans are immersed in hot water to extract the flavor. Different sizes of coffee grounds are needed for various brewing methods. A French press, for example, uses coffee grounds that are very coarse, while the coffee grounds required for Turkish coffee are very fine. The grounds used for drip and Cappuccino makers fall in between those used in a French press and for Turkish coffee. Controlling the coffee ground particle size distribution is important in extracting the best flavor for the applied brewing method. Undesirable size distributions can lead to over extraction or under extraction of the coffee grounds, which affects the taste of the brew.

Measuring the size of the particles in coffee grounds can be accomplished using particle size analysis based on light scattering technique. Light refracted by a particle creates a scattering angle unique to its shape and size. The intensity of the scattering light is measured by an array of light detectors at different angles. The Mie Theory is the preferred method used to relate the measured scattering angle to the particle diameter. The Mie theory takes the complex refractive index of the particle into account when measuring the particle size. Nonetheless, in applications involving particles with high light absorption or with sizes significantly larger than the laser wavelength, the Fraunhofer Theory can be used to measure particle size. The Fraunhofer Theory is a simplified form of the Mie Theory; relating the scattering angle to the diameter of the particle and the light wavelength using the following equation:

Eq. 1
$$\sin\theta = \frac{1.22\lambda}{d}$$

where θ is the measured scattering angle, λ is the wavelength of the laser light and d is the diameter of the particle. The complex refractive index of the particle required for the Mie Theory is not needed for the Fraunhofer Theory.

Table 1 Particle Size Analysis Results for Coffee Grounds

	Based on Volume			Based on Surface Area			Based on Number		
Brand	Folgers	Starbucks	Dunn Bros.	Folgers	Starbucks	Dunn Bros.	Folgers	Starbucks	Dunn Bros.
Mean (μm)	748.7	558.3	608.1	365.2	247.3	142.8	21.32	17.04	0.68
Median (μm)	764.3	578.8	583.0	198.1	83.42	34.73	14.33	12.38	0.58
Standard Deviation (μm)	361.0	267.7	410.8	374.3	277.3	257.8	31.74	22.13	1.10

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The LS 13 320 Laser Diffraction Particle Size Analyzer, manufactured by Beckman Coulter, is capable of measuring particles suspended in a liquid medium or in a dry powder form by using specially designed sample modules. The module capable of measuring dry powders is the Tornado Dry Powder System (DPS). The Tornado DPS is capable of measuring particle size of dry powders from 2mm to 0.4µm without a liquid medium. The LS 13 320 is designed to be compliant with ISO 13320, the standard pertaining to particle size analysis through laser diffraction.

The data presented here are three commercially available coffee brands, Folgers, Starbucks and Dunn Brothers. The Folgers and Starbucks coffee grounds came packaged from a local supermarket. The Dunn Bros. coffee grounds were freshly ground from a local franchise. All three brands are for a drip coffee maker. Using the LS 13 320 and Tornado DPS, the coffee grounds were sized. The results presented in Table 1 and Figure 1 show differences in size distribution among the prepackaged coffee grounds (Folgers and Starbucks) and the freshly ground coffee grounds (Dunn Bros.).

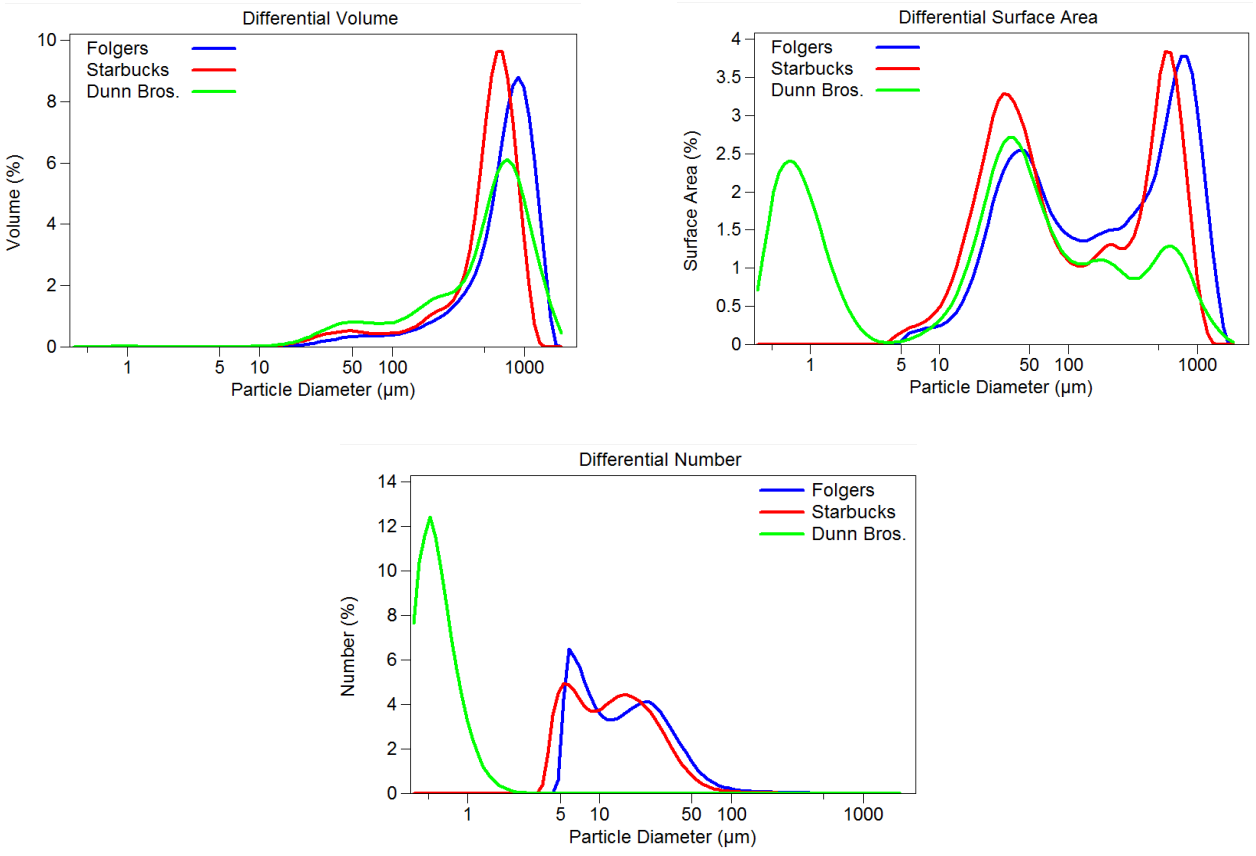

Figure 1. Particle size distributions based on differential volume, surface area and number for the tested coffee grounds made by Folgers, Starbucks and Dunn Brothers.

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