Application News

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Size, Concentration, and Shape Evaluation of Particles in Beverages: Quantitative Evaluation of Beverage Texture

The size, concentration, and shape of particles in beverages affect the texture of the beverage when consumed. If the particle size exceeds about 20 µm, a beverage will feel rough on the tongue. Beverage texture also differs depending on the concentration and shape of the particles. Laser diffraction method and microscopic observation are used as methods for evaluating particles in beverages. However, laser diffraction method enables quick measurement of the particle size by spherical conversion, but cannot obtain information on the particle shape or concentration. Although particle shape evaluation is possible by microscopic observation, it is difficult to evaluate an adequate number of particles due to the time required by measurements.

The Shimadzu iSpect™ DIA-10 dynamic particle image analysis system (Fig. 1), which is based on the dynamic image analysis method, is an instrument that makes it possible to acquire images of particles in liquid samples and conduct measurements of the size distribution, concentration, and shape of particles, and is capable of measuring tens of thousands of particles in only a few minutes. This article introduces an example of evaluations of particles in PET bottle type green tea beverages and yogurt products using the iSpect DIA-10.

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Fig. 1 iSpect™ DIA-10 Dynamic Particle Image Analysis System

■ Samples and Method

The samples used here were three commercial PET bottle type green tea beverages (A, B: cloudy, C: clear) and two commercial yogurt products (drinkable type, solid type). For the green tea beverages, 50 µL of the undiluted tea was measured. The yogurts were diluted 10,000 times with water, and 50 µL liquid samples were measured.

■ Measurement Results

Fig. 2 and Table 1 show the measurement results of the three types of green tea beverages.
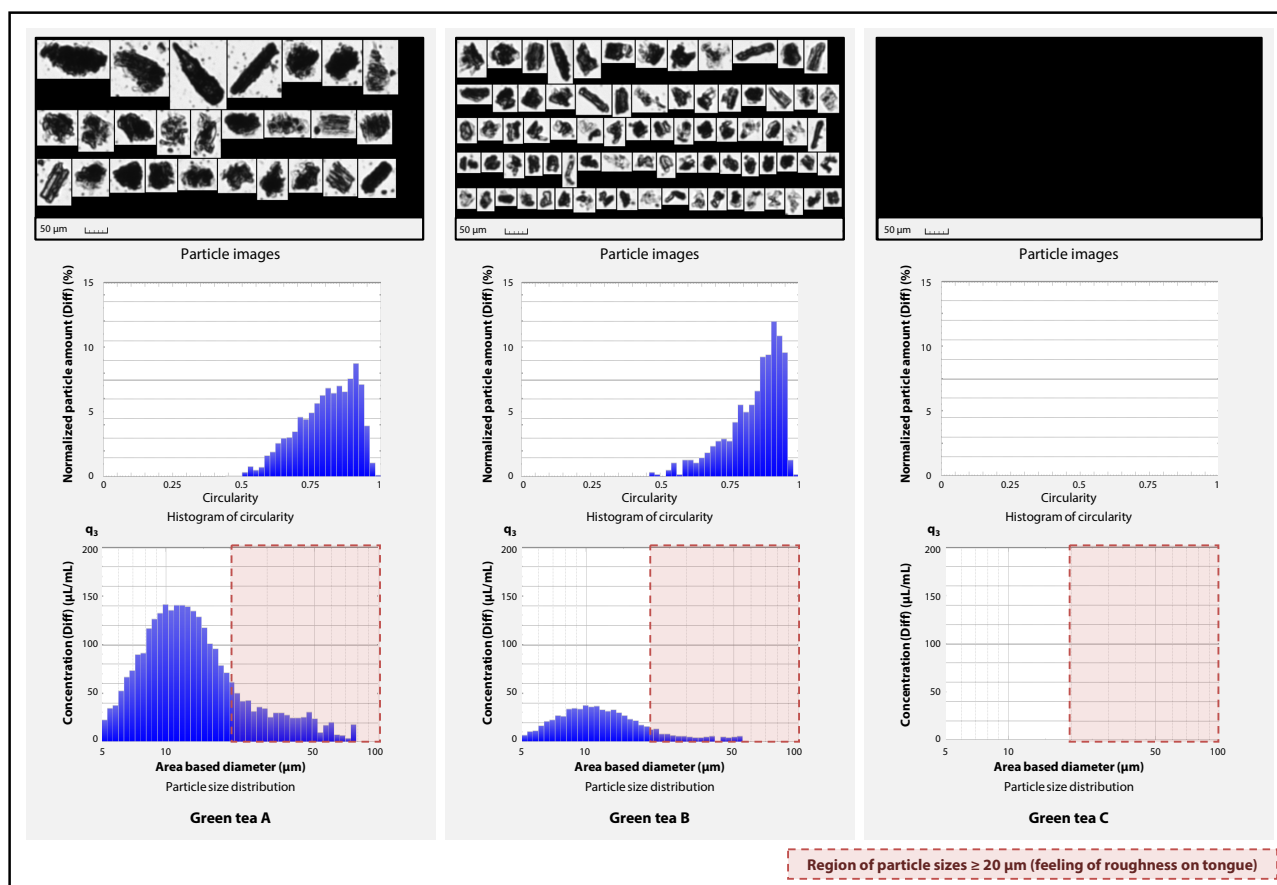

Region of particle sizes ≥ 20 µm (feeling of roughness on tongue)

Fig. 2 Measurement Results of 3 Types of Green Tea Beverages

Table 1 Measurement Results for Particles ≥ 20 μm in Green Tea Beverages

	Green tea A	Green tea B	Green tea C
Particle concentration (particles/mL)*	51859	11198	0
Median diameter (volume standard, μm)*	32.692	28.801	-
Circularity (average)*	0.801	0.841	-

*   Calculated using only detected particles with sizes ≥ 20 μm.

From the particle images, it can be understood that green teas A and B both contain particles with various shapes (circular, rod-shaped). In the clear green tea C, no particles were detected with this instrument. Regarding circularity, many of the particles in green tea A displayed lower circularity than those in green tea B. Average circularity was 0.801 in green tea A and 0.841 in green tea B. From the particle size distributions, although the particle concentration was higher in green tea A than in green tea B, the distribution profiles were similar. The red hatched region in the graphs indicates particles with sizes of 20 μm and larger, which are perceived as having a rough feeling on the tongue. Comparing the concentrations in this region, the particle counts per milliliter were 51,859 for green tea A but only 11,198 for green tea B, indicating that the concentration of particles in this size region is about 5 times larger in green tea A. From these results, it can be thought that green tea A has the roughest feel, while green tea C has absolutely no feeling of roughness.

Next, Fig. 3 shows the measurement results of the two types of yogurt. Particles 20 μm and larger were not detected in the drinkable yogurt. However, in the solid type yogurt, particles which were thought to be aggregates of proteins can be observed in the particle images, and particles with sizes of 20 μm and larger can also be seen in the particle size distribution. Thus, it can be understood that the drinkable yogurt has been adjusted to a particle size which avoids the feeling of solids on the tongue. Here, it was also noted that the aggregate state in the solid type yogurt changes easily, and in such cases, measurement under appropriate dilution rate and mixing conditions is necessary.

■ Conclusion

As described above, a quantitative evaluation of parameters related to the perceived texture of beverages was possible by acquiring particle images and information on the concentration and shape of particles with sizes of 20 μm and larger in green tea beverages and yogurt products by using the Shimadzu iSpect DIA-10 dynamic particle image analysis system. The iSpect DIA-10 is capable of analyzing tens of thousands of individual particles in only a few minutes and can acquire not only size information, but also the particle concentration, shape and particle images, and thus is an effective tool for quantitative evaluations of food and beverage texture.
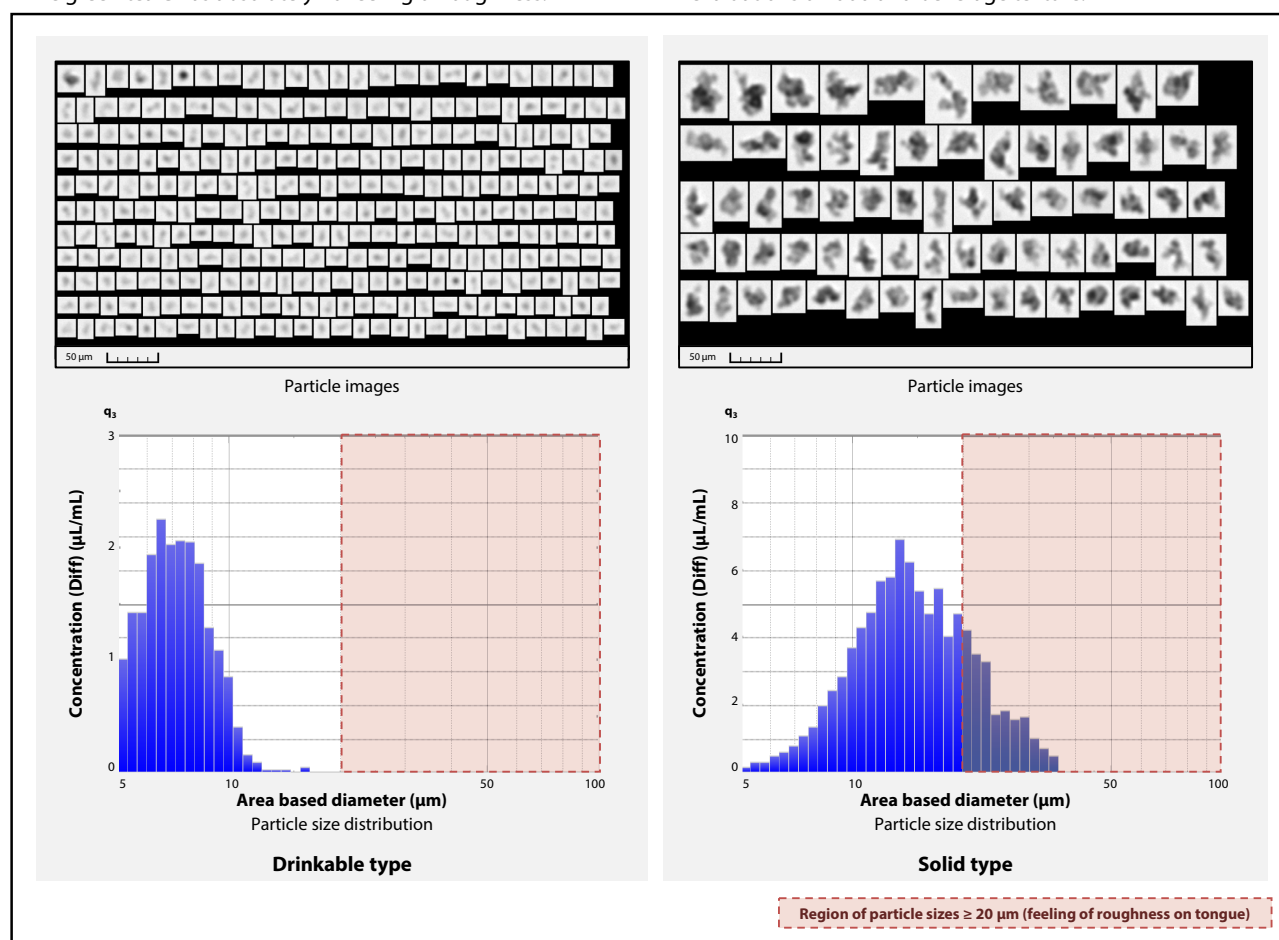

Region of particle sizes ≥ 20 μm (feeling of roughness on tongue)

Fig. 3 Measurement Results of 2 Types of Yogurt

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