PERFECT TEXTURE AND TASTE
ADVANCED PARTICLE SIZE ANALYSIS OF CHOCOLATE

CONTEXT

Particle size analysis is a central topic in the quality control and development of chocolate. The sensory properties, especially the mouthfeel and the melt, are significantly influenced by the size and shape of the particles contained in the product. In particular, the perceived smoothness and creaminess depend on whether the particle sizes are below the sensory perception threshold (approx. 30 µm, R30 value). Precise knowledge of particle size distribution is also crucial for storage stability, flow behavior, and processing. Particle size distribution analysis is, therefore, an essential tool for producers and developers to ensure the consistent quality and enjoyment value of chocolate products.

Table 1: *Cocoa products and typical size ranges*

Cocoa product	***Size and/or Range***
Cocoa Particles Liquor	Median: 50 – 100µm
Cocoa Powder plus sugar	Smaller than 100 µm
Conching process	Start 100 µm, final 15 – 30 µm
Dark Chocolate	Maximum size: 65-75 µm
Milk Chocolate	Maximum size: 25 µm
Chocolate bar	Range: 0.5 – 100 µm, D50: 5 – 10 µm
Cocoa, sugar, milk solids mix.	Typically, less than 30 or 25 µm

Methods

In practice, various methods are used to determine the particle size distribution in chocolate. Common methods in a modern QC lab include:

1. **Laser Diffraction:** The laser diffraction method has established itself as a standard procedure in recent decades. In this process, a chocolate sample dispersed in a solvent is illuminated by a laser beam. The scattering pattern of light provides information about the size distribution of the particles, ranging from about 0.01 to 2000 µm. Devices such as the MICROTRAC SYNC are widely used. Laser diffraction is fast and provides a good statistical statement about small sample quantities.

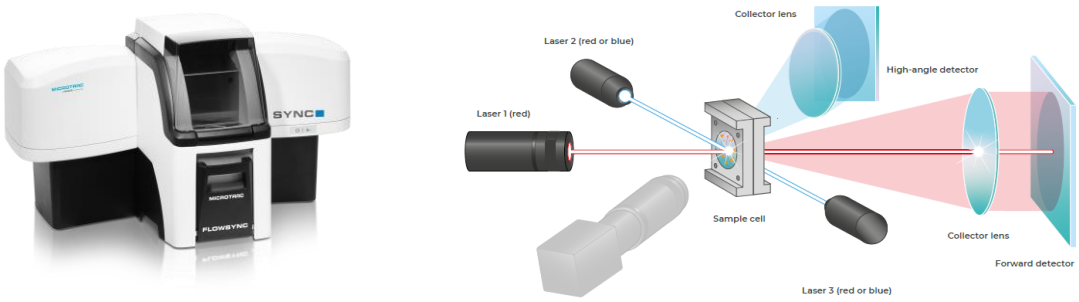

Figure 1: *Microtrac SYNC analyzer and functional sketch of the optical arrangement using laser and imaging technology*

2. **Dynamic Image Analysis:** Dynamic Image Analysis (DIA) with the CAMSIZER is ideal for chocolate because it delivers direct particle visualization, enabling accurate detection of oversized sugar or cocoa fragments that strongly affect mouthfeel. Its dual-camera system captures fine and coarse particles simultaneously, providing high-resolution size and shape data without relying on optical models. DIA enables direct differentiation between particles, agglomerates, and air bubbles based on shape and transparency, which cannot be reliably distinguished by laser diffraction alone. With minimal sample preparation and fast, statistically robust measurements, the CAMSIZER gives manufacturers precise control over smoothness, refining efficiency, and overall chocolate quality, making it uniquely powerful for both QC and process optimization.

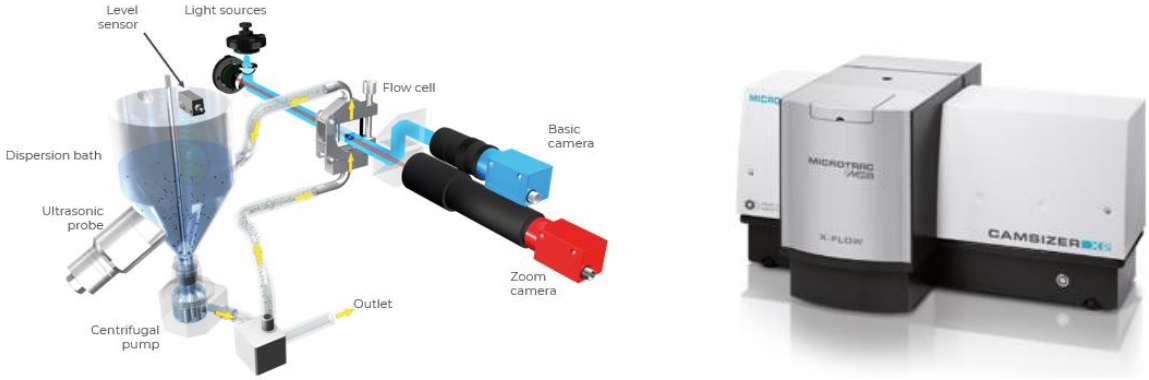

Figure 2: *Functional sketch of the CAMSIZER X2+ wet dispersion module equipped in a Camsizer X2+ instrument using patented dual imaging technology*

3. **Sieve analysis:** This mechanical process is mainly used for coarse-grained raw materials like chocolate nibs or coarser ingredients (nuts, fruits, sweets). However, it is less suitable for chocolate particles, as most of the particles are in the lower micrometer range.
4. **Sedimentation analysis:** The sinking rate of the particles in a liquid is evaluated. However, due to the high viscosity of chocolate and the small size of the particles, this process is complex and not very common.
5. **Traditional methods:** To this day, traditional methods are still widely used, such as employing a micrometer screw gauge, a Hegman gauge, or relying on sensory evaluation. These approaches are highly subjective, prone to error, and often require many years of experience to yield reliable results.

Sample preparation

Chocolate samples and similar materials (e.g., nougat products) require sophisticated sample preparation. Relevant standards recommend nonpolar solvents such as isoparaffin (ISOPAR G) as suitable dispersion media. In this application note, we use low-viscosity vegetable oil as an easy-to-handle alternative. Sample preparation takes place externally; a part of the sample is introduced into the dispersion medium and homogenized using an ultrasound bath. Sample preparation can be accelerated by gentle heating to max 30 °C, which promotes dissolution of the fatty components.

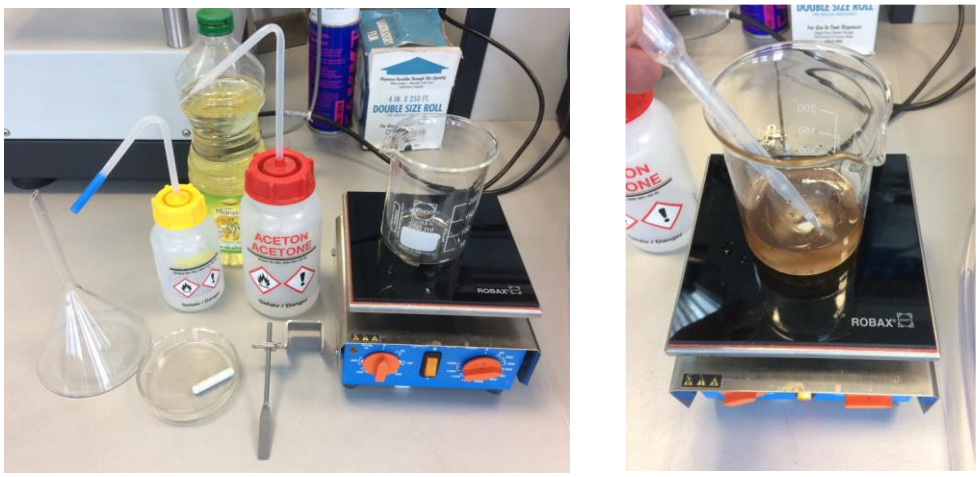

Figure 3: *Recommendation of useful equipment and liquids (left); Sample preparation in vegetable oil on a stirrer plate tempered at 30-35°C (right)*

Example 1: Chocolate A/B/C (SYNC – Laser Diffraction + Imaging)

Chocolate A/B/C represents three typical chocolate categories: milk chocolate (A), white coverture (B), and dark chocolate (C). Each exhibits different particle size characteristics due to its formulation, fat content, and refining conditions. Particle size distribution (PSD) and the presence of coarse particles are key indicators of consumer-perceived smoothness. The perceived smoothness strongly depends on the fraction of particles above approximately 30 µm (often expressed as R30), which represents the typical sensory detection threshold for solid particles in chocolate.

Laser Diffraction (LD) is widely used in chocolate quality control because of its speed and reproducibility. The Microtrac SYNC enhances LD by integrating an onboard camera, enabling visual verification of dispersion, detection of bubbles/agglomerates, and complementary imaging-based shape hints.

Measurement Overview

- Instrument: Microtrac SYNC (LD + Imaging)
- Medium: Terlitol D30 (white spirit) + Lecithin (emulsifier)
- Optical Model: RI chocolate = 1.60; RI medium = 1.42
- Preparation: External pre-dispersion, 30 seconds in ultrasonic bath

  (Note: Gently warm samples that are particularly high in fat.)
- 6-9 ml of pre-dispersed sample transferred to the SYNC analyzer until a suitable loading index was reached.

Results

Chocolate A, B, and C showed distinct coarse-fraction levels (R30, particles > 30 µm):

- Chocolate A: 0.49 %
- Chocolate B: 3.18 %
- Chocolate C: 1.16 %

Higher R30 indicates coarser particles and potentially a gritty mouthfeel. Sample B (white couverture) underperforms relative to A and C.

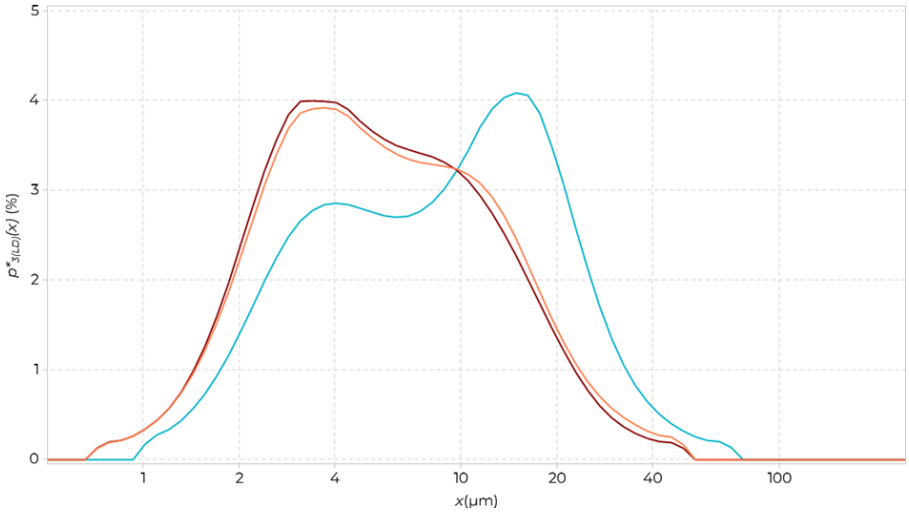

Figure 4: *Particle Size Distributions of the three chocolate samples. Sample A (brown), Sample B (blue), Sample C (orange)*

Table 2: Summary data chocolate sample

	Chocolate A	*Chocolate B*	*Chocolate C*
D10 [µm]	2.041	1.611	2.065
D50 [µm]	5.26	7.19	5.47
D90 [µm]	15.66	21.88	16.53
R30 (% >30 µm)	0.49 %	3.18 %	1.16 %

Imaging & Morphology Results

Representative particle images from the SYNC camera confirm:

- Absence of agglomerates and micro-air bubbles
- Particle shape tendencies matching sugar/fat structures

Figure 5: *Particle Images of Chocolate Sample A*

Figure 6: *Particle Images of Chocolate Sample B*

Figure 7: *Particle Images of Chocolate Sample C*

Example 2: Nougat V1–V6 (SYNC – Process Variants)

Nougat V1–V6 represent six process variations of a hazelnut-nougat cream. The variations reflect differences in:

- Sugar type (powdered vs crystalline),
- Mill size (small vs large),
- Lecithin content,
- Refining time

Nougat is highly sensitive to dispersion conditions because fat phases can entrap air or embed agglomerates, creating misleading coarse tails in PSD curves.

Measurement Overview

- Instrument: Microtrac SYNC
- Media: Tempered vegetable oil
- Preparation: external ultrasonic bath.
- Optical Model: Fraunhofer approximation (absorbing sample)

The test samples were extracted from the homogenized mass using a laboratory spatula (drop-sized test sample) and externally pre-tempered in vegetable oil (35-40 °C) and dispersed by ultrasound.
About 10-20 ml of the pre-dispersed sample was fed to the device by means of a disposable pipette.

Results: PSD Overlay Nougat V1–V6

The six variants show noticeable PSD shifts:

- V1–V2: Finer distributions (d90 < 20 µm)
- V3 & V4: Slightly coarser due to crystalline sugar
- V5: Coarser tail due to modified lecithin content
- V6: Reference sample

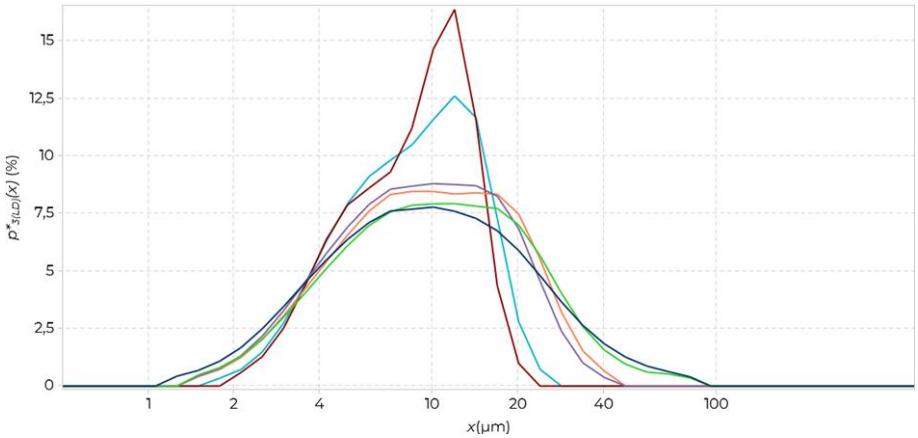

Figure 8: *Particle size distributions of the Nougat samples, measured in tempered vegetable oil. V1 (light blue), V2 (brown), V3 (orange), V4 (purple), V5 (green), V6 (dark blue).*

Table 3: *Summary data nougat samples*

	Nougat V1	Nougat V2	Nougat V3	Nougat V4	Nougat V5	Nougat V6
D10 [µm]	3.93	4.04	3.65	3.56	3.64	3.30
D10 [µm]	8.77	8.98	9.63	9.19	10.26	9.55
D90 [µm]	15.8	14.33	22.56	20.99	26.81	27.69

Imaging & Morphology

The SYNC camera provided morphological insights based on particle shape evaluation:

- The aspect ratio (b/l) distribution showed the presence of elongated particles (likely remnants of ground hazelnuts)
- Transparency allowed identification of sugar fragments
- Filtered image panels reveal differences in milling conditions

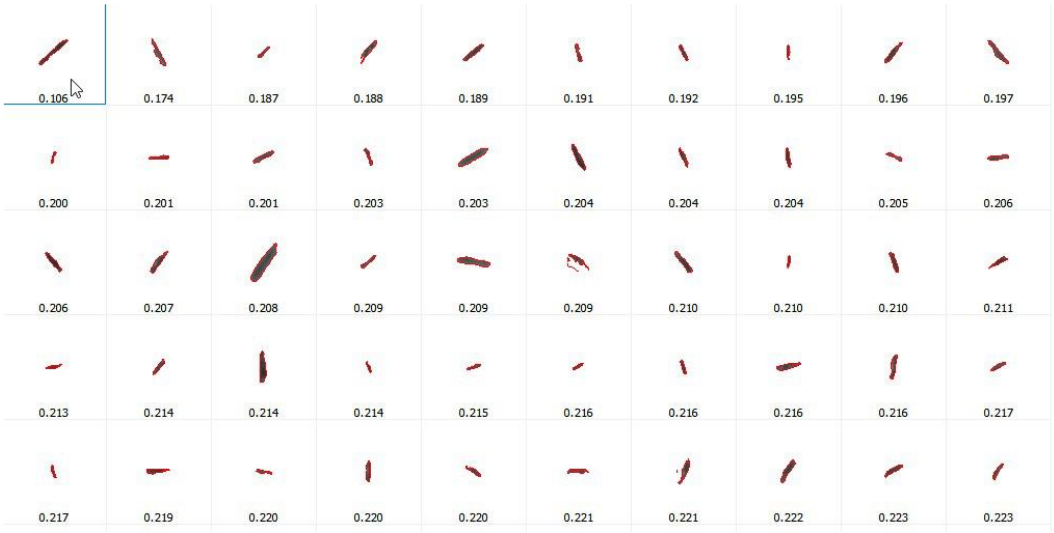

Figure 9: *Nougat particles with low aspect ratio (hazelnut residues)*

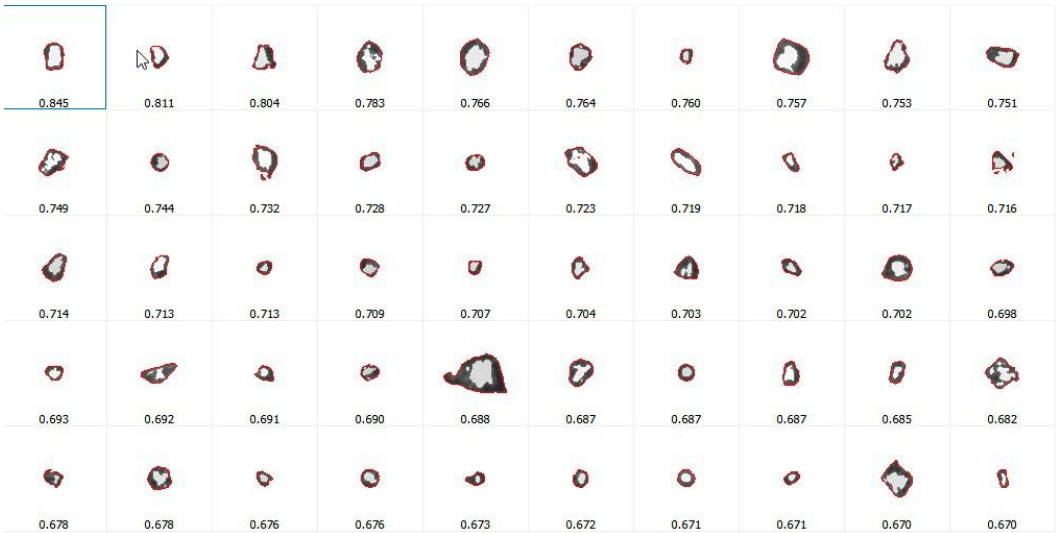

Figure 10: *Nougat particles with high transparency (sugar)*

Example 3: Chocolate and Nougat Analysis with CAMSIZER X2+

Introduction

Dynamic Image Analysis (DIA) with the CAMSIZER X2+ particle analyzer provides high-resolution size and shape analysis with real particle images at high frame rates. It is uniquely valuable for chocolate and nougat because morphology — Including aspect ratio, symmetry, and detection of oversized sugar or nut fragments — directly determines mouthfeel and processing behavior.

Compared to pure laser diffraction, DIA with the CAMSIZER provides:

- true particle geometry (morphology) based on images for each detected particle
- superior oversize detection accuracy
- robust morphological metrics (b/l, symmetry, convexity)
- high statistical significance (dual camera, up to >420 fps)

Measurement Overview

- **Instrument:** MICROTRAC CAMSIZER X2+
- **Module:** X-Flow liquid dispersion system
- **Medium:** Warm vegetable oil (30–40 °C)
- **Key parameters:** Low pump speed, no ultrasound, camera-based bubble detection
- **Samples:** Nougat (two variants), chocolate rolling-mill sample, and fine/coarse fractions

Results

Oversize Detection >30 µm:
CAMSIZER X2+ identifies oversized particles with high precision. Oversized sugar crystals, nut fragments, and agglomerates appear as distinct spikes in q3 distributions.

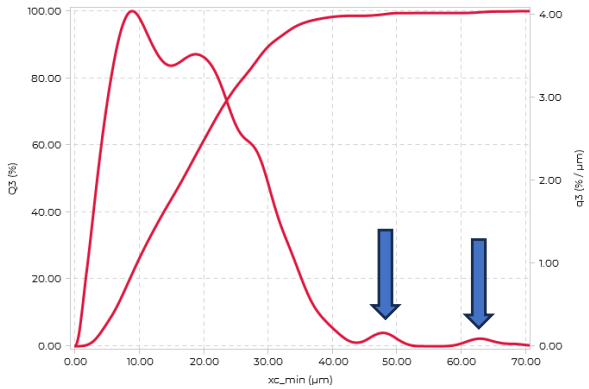

Figure 11: *Size distribution of a Nougat sample, measured with CAMSIZER X2+, showing significant oversize (arrows).*

Morphological Attributes

- **Aspect Ratio (b/l):** Differentiates elongated cocoa particles from compact sugar crystals.
- **Symmetry:** Indicates roundness; asymmetry flags incomplete refining.
- **Convexity / Transparency:** Distinguishes air bubbles and fat droplets.

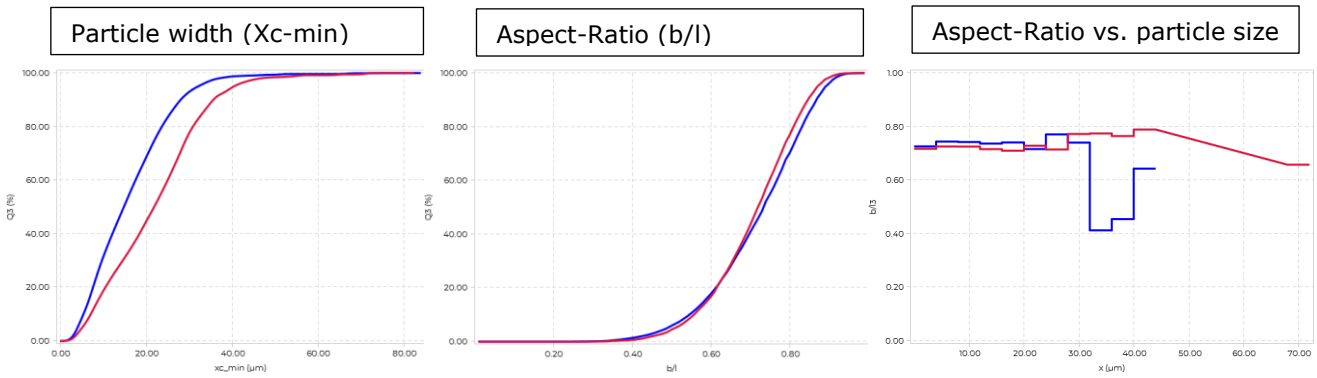

Figure 12: *Comparison of a chocolate sample from the roller mill (red) and a nougat sample (blue).*

The figure compares a chocolate sample from the roller mill (red) with a nougat sample (blue).

Left: Size distributions. The nougat sample is finer.
Middle: Q3 distribution of the aspect ratio. The curves intersect, which means that the nougat sample contains more round components and more elongated components, while the shape of the chocolate sample particles is more uniform.
Right: Aspect ratio as a function of size. The chocolate sample has similar shape values for all sizes contained. The nougat sample has a particularly low aspect ratio (elongated particles) in the 30-40 µm range.

Particle Images

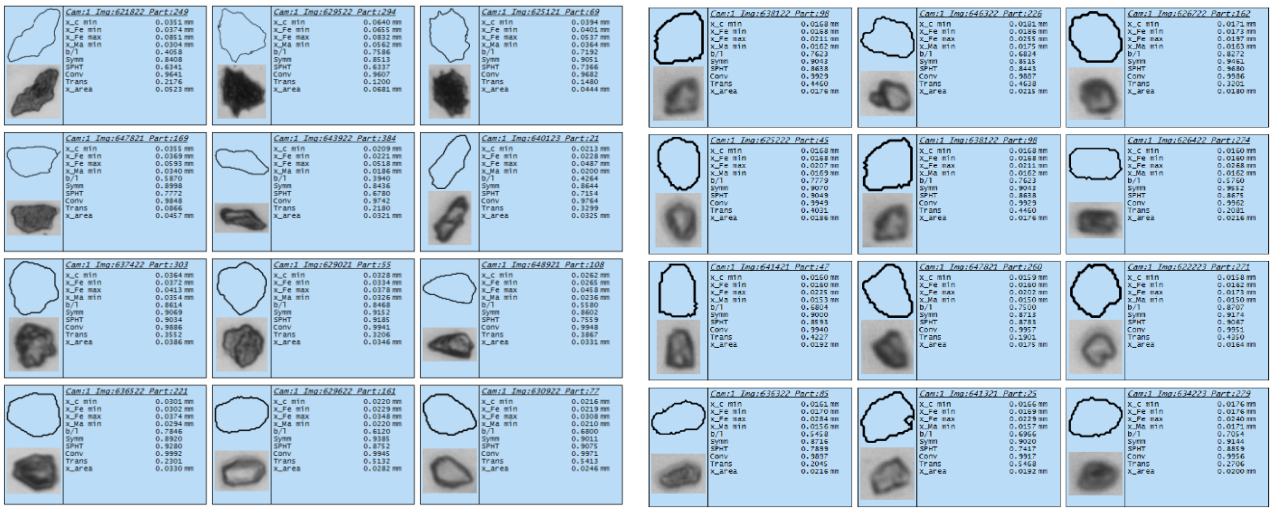

Figure 13: *CAMSIZER X2+ Nougat particle images > 30 µm (left) and particles < 20 µm (right)*

CONCLUSION

The results of this study clearly demonstrate that **particle size and particle morphology are decisive quality parameters** in chocolate and nougat production. Laser diffraction with the **MICROTRAC SYNC** provides fast, robust quantification of particle size distributions and reliable coarse-fraction metrics such as

the R30 value. The integrated camera additionally ensures confidence in dispersion quality by visualizing bubbles, agglomerates, and structural anomalies during analysis.
Dynamic Image Analysis with the CAMSIZER X2+ extends these capabilities by delivering **true particle-by-particle imaging**, enabling precise identification of oversized sugar crystals, nut fragments, and morphological details that directly influence mouthfeel and refining performance. High-resolution shape parameters (b/l, symmetry, convexity) allow deeper insight into process efficiency and help manufacturers optimize conching, milling, and overall product texture.

Together, SYNC and CAMSIZER X2+ form a complementary toolkit for the highest quality control demands:

- **SYNC** for fast, routine QC measurements with imaging-assisted reliability
- **CAMSIZER X2+** for advanced morphology analysis, troubleshooting, and process optimization

By combining both technologies, chocolate manufacturers gain a comprehensive, data-driven understanding of particle behavior—ultimately supporting **consistent quality, improved sensory performance, and enhanced control of their production processes**.

MICROTRAC SYNC – Particle Size & Shape Analyzer - Laser Diffraction & Dynamic Image Analysis

Learn more

MICROTRAC CAMSIZER X2+ - Particle Size & Shape Analyzer – Dynamic Image Analysis

Learn more