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TECHNISCHE HOCHSCHULE LÜBECK

INFLUENCE OF PARTICLE SIZE ON COLOR OF R&G COFFEE

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Rationale

Methods to quantify roast color are of high importance in process control for coffee manufacturers and are used in coffee research to describe the roast degree. Different optical principles are applied; Industry uses special color scales today often based on reflectance values at 640nm and scientific publications use various systems/scales. Color determination of particulate matter of natural origin is not trivial at all and research is ongoing [1,2]. It is known that particle sizes can influence color readings but nevertheless this effect is often neglected.

Methods

Commercially available roasted arabica coffees were used (Tchibo GmbH, Germany). Beans were ground with a lab burr disk Coffee Grinder EK43 (Mahlköning, Germany, fig.1) and color values obtained with a spectrophotometer CM-5 (Konica Minolta Sensing, Japan; fig2). Ground coffee was placed in clear optical glass dishes Ø 60mm (target size Ø 30mm, 10°C, D65). Reflectance at 640nm and L*,a*,b*,c* were determined, at least five times. An Air Jet Sieve Machine (Alpine, Germany) with certified test sieves (NEXOPART GmbH&Co.KG; Germany) was used to obtain R&G coffee samples with a span of ~ 200µm – indicated in this text as "narrow particle size distribution NPSD". A Dynamic Image Analysis System QICPIC – Rhodos/Succell (Sympatec GmbH, Germany; fig.3) was used to determine particle size distributions (PSD).

Results

In previous investigations [4] was shown, that different available R&G coffee color determination systems can lead to different color values (fig.4). The strong influence of individual sample preparation is well known. In this study shaking of the samples or compacting with weights was investigated systematically: influence on all color readings is not negligible (see fig.5.+6). All further measurements were made avoiding any shaking movement and under reproducible compaction.

Fig. 7 illustrates the expected findings: especially for particle sizes D_{50} < 500 µm color values are significantly influenced: Reflectance at 640 nm increases with decreasing particle size for a filter and an espresso coffee sample. The same was detected for L* values, a* and b* values decrease (not depicted here). This effect can increase, when samples of more uniform particle size (narrow PSD) are investigated. The influence on color is then easily observable with the naked eye (fig.9). Fig. 7 furthermore additionally illustrates the influence of sample temperature and industrial grinding vs lab milling.

Smaller particle sizes result in a finer texture which creates a smoother coffee surface. Thus when a detecting light ray hits this smoother surface, the rate of absorbance is relatively low due to minimal pores, leading to higher reflectance and Luminscence L* values. The same was detected for a* and b* values (not depicted here) and Chromaticity c* does not work well for R&G. Positive values of a* indicate more reddisch and b* more yellowish.

Conclusions & Perspectives

The effect of particle sizes, particle size distributions and thus the applied milling technology on various color readings is not negligible. In industry grinders for process samples need monitoring and in scientific studies PSD should be recorded and deliberately chosen. Research is continued.

Fig.1 Burr Grinder

Fig.2 Spectrophotometer

Fig.3 Dynamic Image Analysis

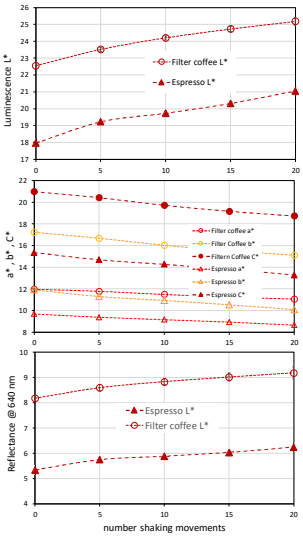

Fig.5 influence of shaking samples

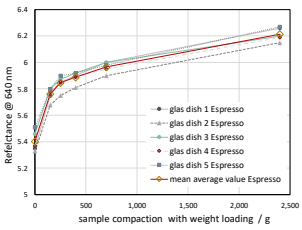

Fig.6 influence of compacting samples

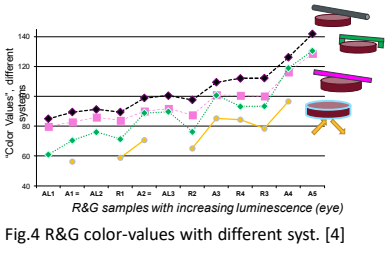

Fig.4 R&G color-values with different syst. [4]

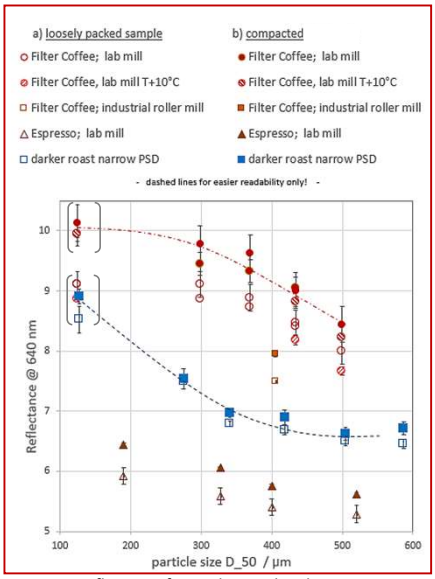

Fig.7 influence of particle size distribution

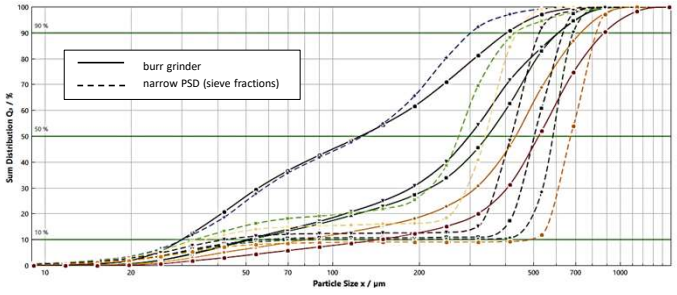

Fig 8. PSD of investigated samples

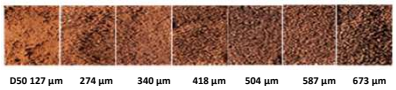

Fig.9 Foto identical arabica coffee, sieved particle size fractions ; narrow PSD

[1] Anokye-Bempah, L., Styczynski, T., Ristenpart, W.D. et al. *A universal color curve for roasted arabica coffee*. Nature Sci Rep 15, 24192 (2025).
[2] De Carvalho Pires F., Da Silve Mutz, Y. et al. *Feasibility of using colorimetric devices for whole and ground coffee roasting degrees prediction*. J Sci Food Agric 104, (2024)
[3] Mugabi,R. *Effect of Particle Size on Color of Ground Coffee*, AFSJ 75316 (2010)
[4] Pietsch.A.; Ametepey, D: *Hintergründe und Varianten der Farbbestimmung von Röstkaffee*, GDL Kongress Lebensmitteltechnologie 2024, Lemgo