
Article:
Manga, MS orcid.org/0000-0001-8976-4792, Willis, D, Nurafiqah, MA et al. (1 more author) (2019) The impact of raw material properties and process conditions on the color of a powdered formulated detergent product. Particuology, 45. pp. 35-41. ISSN 1674-2001

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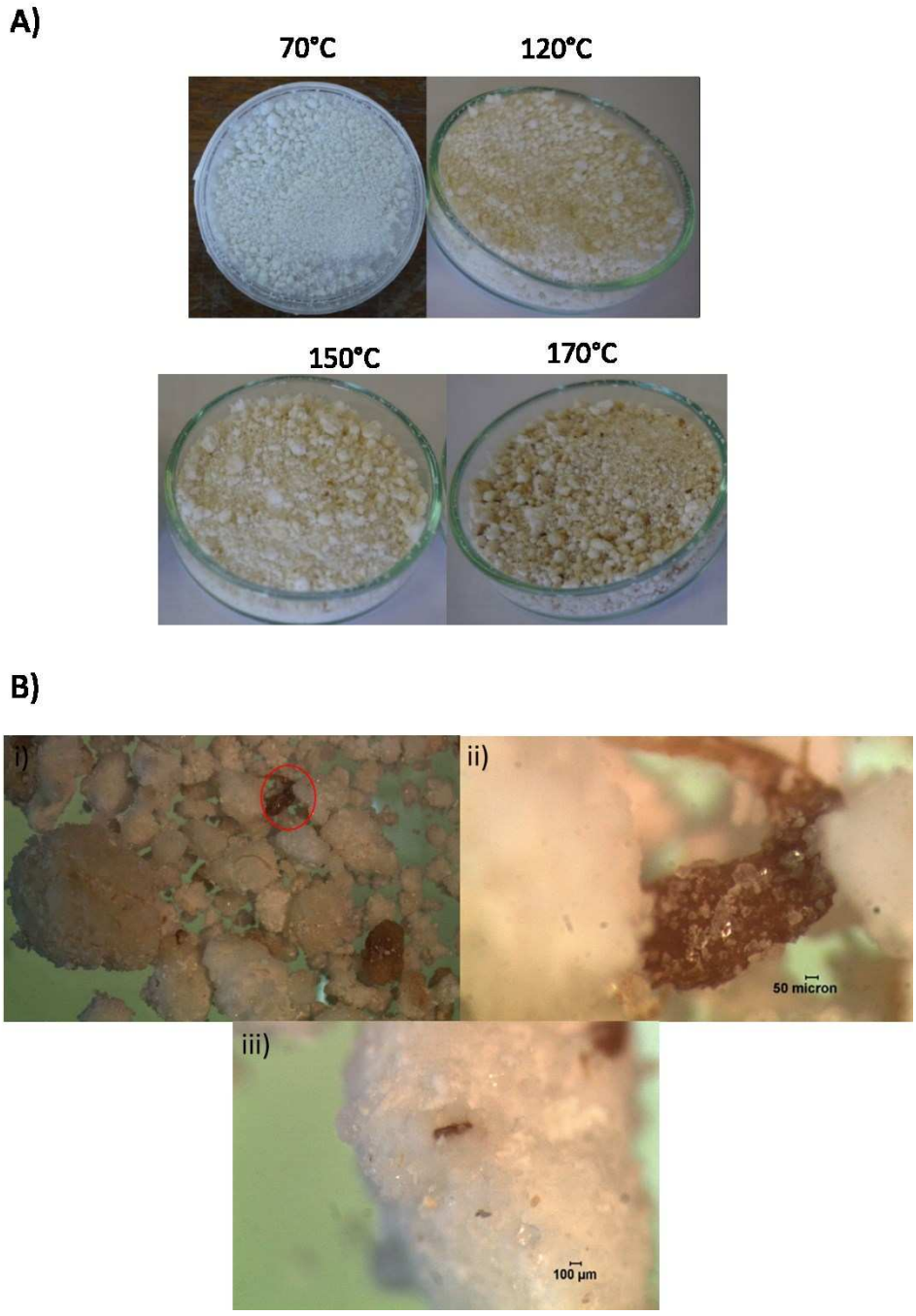

Figure 1. Influence of convection oven drying temperature discoloration of detergent powder; a) Images of samples at different temperature, i) 70°C (sample 1), ii) 120°C (sample 2), iii) 150°C (sample 3) and iv) 170°C (sample 4) and b) closer examination of granules from sample 4 dried at 170°C.

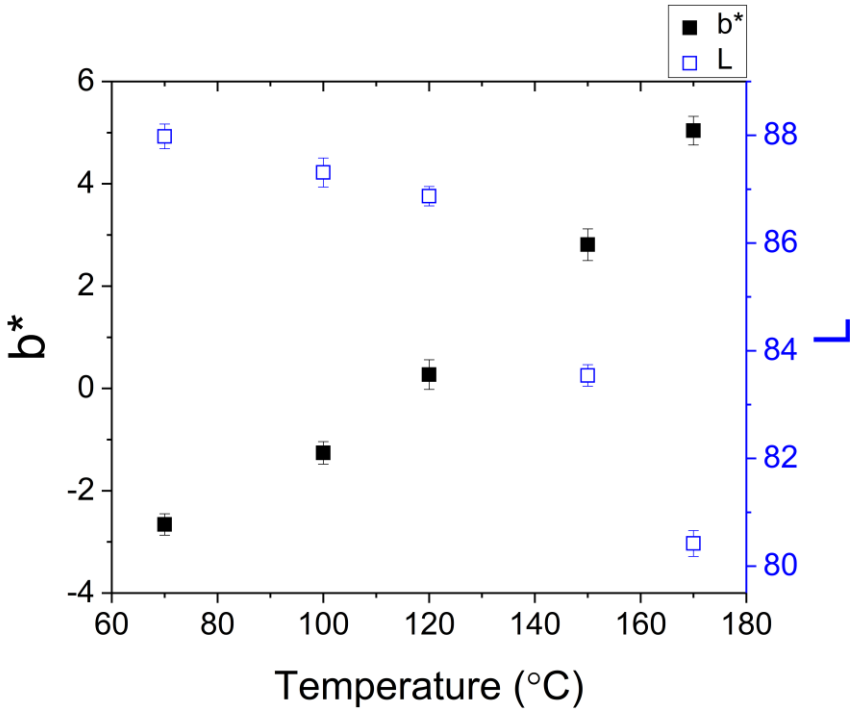

Figure 2. Influence of convection oven drying temperature on the measured L and b* values of the product samples. Samples 1 to 4 in the supplementary information were used for analysis.

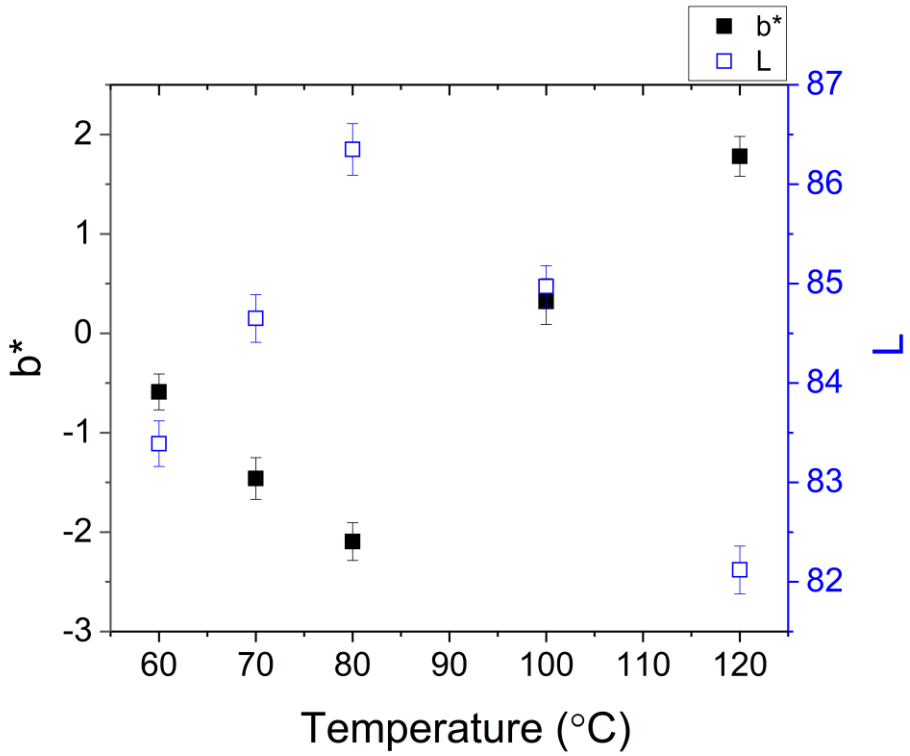

Figure 3. Influence of fluidized bed drying temperature on the measured b* and L values of the product samples. Samples 5 to 9 in the supplementary information were used for analysis.

Figure 4. Digital images of a detergent powder sample as a function of particle size; a) unsieved sample, b) above 841 microns, c) 500 - 841 microns, d) 250 - 500 microns and e) below 250 microns. These correspond to samples 10 to 14 in the supplementary information.

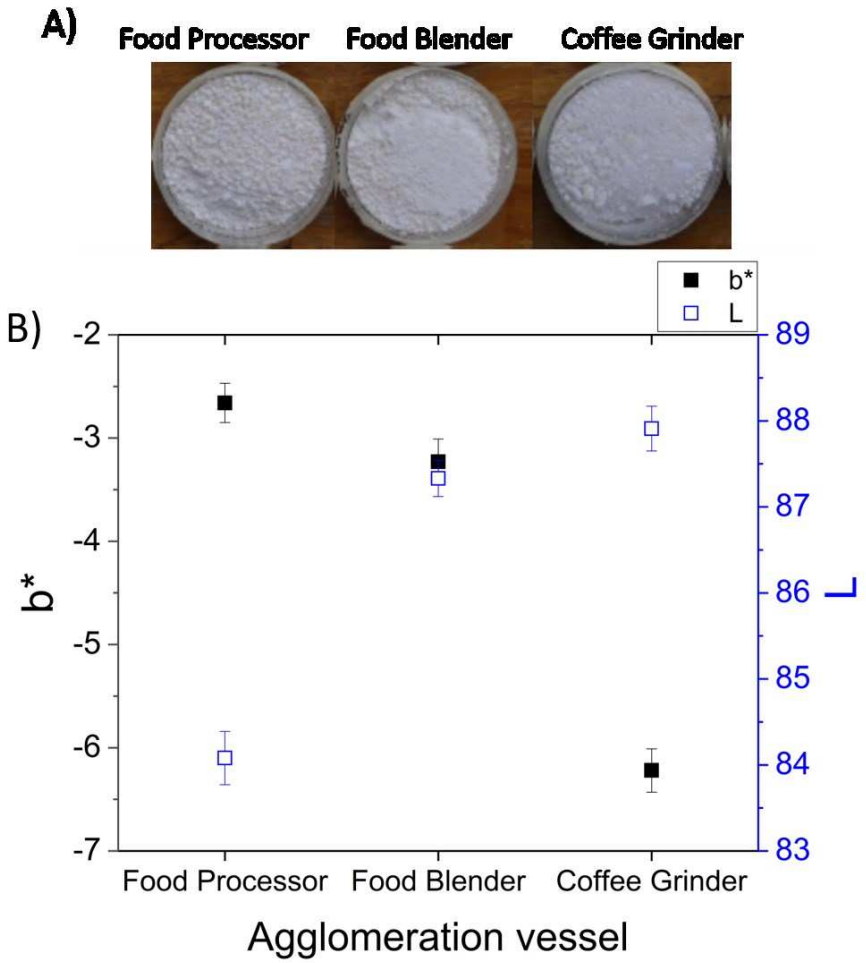

Figure 5. Influence of agglomeration vessel on measured color properties of resultant detergent granules. These correspond to samples 15 to 17 in the supplementary information.

Figure 6. Differences in the appearance of research grade (left sample) and commercial grade (right sample) for a) HLAS and b) sodium silicate.

Table 1. Variation in the measured L and b* values and mass % contribution as a function of particle size.

	Color space values		
Sieve Fractions	**L**	**b***	**Mass % of sample**
Unsieved sample (sample 10)	89.01 ±0.26	-4.75 ±0.19	-
Above 841 μm (sample 11)	84.03 ±0.31	-3.53 ±0.16	43.54
500 - 841 μm (sample 12)	88.35 ±0.22	-4.42 ±0.22	27.29
250 - 500 μm (sample 13)	89.63 ±0.28	-5.67 ±0.21	23.57
Below 250 μm (sample 14)	90.59 ±0.26	-6.58 ±0.25	5.60

Table 2. Influence of agglomeration vessel on the Mass % of detergent powder sample as a function of particle size.

	Food processor		**Food Blender**		**Coffee Grinder**	
Sieve Fractions	**Mass fraction (%)**	**b***	**Mass fraction (%)**	**b***	**Mass fraction (%)**	**b***
Above 841 µm	39.58	-2.23 ±0.21	24.75	-2.83 ±0.18	25.4	-5.41 ±0.24
500 - 841 µm	31.88	-2.75 ±0.28	25.27	-3.36 ±0.20	10.83	-6.16 ±0.19
250 - 500 µm	20.93	-3.51 ±0.20	32.53	-4.21 ±0.23	36.99	-7.35 ±0.18
Below 250 µm	7.61	-4.36 ±0.27	17.39	-5.16 ±0.31	26.78	-8.41 ±0.22

Table 3. Effect of Tinopal dispersion vehicle on detergent color. Sample numbers correspond to further details that can be found in the supplementary information.

Tinopal addition method	L	b*
Dispersed as a pre-blend powder (sample 18)	86.99 ±0.31	-2.31 ±0.23
Dispersed in Water (sample 19)	88.08 ±0.24	14.35 ±0.38
Dispersed in Neonol (sample 20)	89.01 ±0.28	-4.75 ±0.25
Dispersed in Sokolan polymer solution (sample 21)	89.01 ±0.21	1.54 ±0.22
No Tinopal added (sample 22)	86.84 ±0.29	4.52 ±0.26

Table 4. Influence of spraying on vs. pouring on of Tinopal in Neonol dispersions on granule color.

Tinopal in Neonol dispersion addition method	L	b*
Poured on (sample 23)	89.01 ±0.28	-4.75 ±0.25
Sprayed on (sample 24)	91.35 ±0.21	-6.52 ±0.21
2nd Spray addition after drying (sample 25)	91.72 ±0.24	-6.98 ±0.18
3rd Spray addition after drying (sample 26)	91.83 ±0.22	-7.43 ±0.19

Table 5. Influence of raw material purity grade on measured detergent powder color.

	Commercial grade		**Research grade**	
Chemical	**L**	**b***	**L**	**b***
HLAS (sample 27)	86.82 ±0.41	-1.03 ±0.21	87.25 ±0.33	-3.91 ±0.18
Sodium Carbonate (sample 28)	84.69 ±0.26	-1.87 ±0.26	84.98 ±0.28	-2.10 ±0.19
Sodium Sulfate (sample 29)	84.24 ±0.21	-1.37 ±0.15	84.65 ±0.26	-1.98 ±0.22
Sodium Silicate (sample 30)	84.61 ±0.31	-0.57 ±0.19	85.42 ±0.29	-1.83 ±0.20
All four raw materials (sample 31)	87.03 ±0.34	-1.53 ±0.22	86.82 ±0.30	-3.08 ±0.21