

Color Change in and Soil Removal from Cocoa Soiled Cloth in Hard Water

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ABSTRACT

IEC 60456 declared the cocoa soiled cloth to be one of the standard soiled test cloths for measuring the performance of the clothes washing machines. Researchers for textile washing have known that cocoa soiled cloth has shown unpredictable washing performance. The color of cocoa mainly comes from flavonoids, and flavonoids reversibly change color with alkalinity from pH 1 to pH 7 as food colorants. The color change of flavonoids under various washing conditions, in the alkali solution, has not yet been confirmed. In this study, we have investigated the color change and the soil removal of the cocoa soiled cloth which were washed with alkaline washing liquids of various hardnesses. The cocoa soiled cloth which was washed in the water which was 60ppm or higher became darker than the soiled cloth. When the cloth was washed in the detergent solution, the cloth was slightly darker only when the washing condition was 20°C and 250ppm. As the water hardness increased, the soil removal decreased and the higher washing temperature was more effective.

1. INTRODUCTION

Cocoa is the dry powder made by grinding cacao beans and removing the coconut butter, it also refers to the drink hot chocolate. Hot chocolate is one of the favorite drinks for children; therefore parents who have little ones frequently face cocoa stains. IEC 60456 declared the cocoa soiled cloth to be one of the standard soiled test cloths for measuring the performance of the clothes washing machines.

The dark brown or the purple coloring matters of cocoa powder are the pigments of flavonoids[1], which have powerful antioxidant properties[2]. More than 500 flavonoid pigments have been identified in nature, with most of the structural variation coming from glucoside substitution at the 3 and 5 positions or in the sugar residues[3]. Researches have shown that flavonoids reversibly change color with alkalinity from pH 1 to pH 7 as food colorants[4], but the color of flavonoids at the washing conditions, in the alkali solution, has not yet been confirmed. Most pigments and dyestuffs react with metals in a bath and form dye-metal complexes, and then they became darker[5].

In this research, we have investigated the color and the soil removal of the cocoa soiled cloth in the alkaline washing solutions of various hardnesses.

2. EXPERIMENTAL

Materials and reagent

Cocoa soiled cloth (EMPA 112) was purchased from EMPA Test Materials. Heavy duty powder detergent for drum type washing machine (Persil, Henkel) was used. CaCl_2 , $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ and NaHCO_3 were purchased from Samchun Chemicals, in order to adjust the water hardness according to IEC 60734.

Methods

Cocoa soiled cloth was washed in the liquid of 0, 30, 60, or 250ppm water hardness. Two washing solutions were used; one group was adjusted to the proper water hardness but no detergent was added, 1.350 g/l of detergent was added to the second group. The cloth was washed for 20 minutes with a Launder-O-meter at 20°C or 40°C. The samples were then rinsed twice with the water of the same hardness and finally air-dried.

To determine the color differences between the soiled cloth and the washed cloths, ΔL^* , Δa^* , Δb^* , ΔC^* , and Δh were measured using a Macbeth Color-Eye 2180. To calculate the soil removal, the K/S values of the cloths at 540nm were measured.

3. RESULTS AND DISCUSSION

Table 1. Color difference of cocoa soiled cloth washed in the various hardened water.

Temperature (°C)	Water Hardness (ppm)	Without Detergent					With Detergent				
		ΔL^*	Δa^*	Δb^*	ΔC^*	Δh	ΔL^*	Δa^*	Δb^*	ΔC^*	Δh
		20	0	-0.1	-0.5	-1.5	-1.6	-0.8	10.6	-3.7	-10.7
	30	-0.9	-0.4	-1.2	-1.3	-0.6	6.8	-3.0	-9.3	-9.6	-7.2
	60	-1.2	-0.5	-1.3	-1.4	-0.4	3.1	-2.2	-7.5	-7.6	-5.9
	250	-2.2	-0.7	-1.1	-1.3	0.3	-0.3	-1.1	-5.9	-5.7	-6.0
40	0	1.8	-1.2	-2.8	-3.0	-0.4	11.9	-3.2	-12.7	-12.3	-18.7
	30	0.2	-0.9	-2.0	-2.2	-0.2	9.3	-2.8	-11.9	-11.4	-16.9
	60	-0.3	-0.9	-2.0	-2.2	-0.5	8.9	-2.6	-11.8	-11.3	-17.1
	250	-1.8	-0.9	-1.8	-2.0	-0.1	1.9	-1.0	-8.3	-7.6	-11.9

Color change

The value of the color components of the cocoa soiled cloth before washing was $L^*=71.6$, $a^*=9.6$, $b^*=19.2$, $C^*=21.5$ and $h=63.4$. All the color difference components (ΔL^* , Δa^* , Δb^* , ΔC^* , and Δh) of the washed cocoa soiled cloths had negative values, except ΔL^* of the most washed cloths in the detergent solutions. As the water hardness increased, the color difference of all the washed cloths decreased. In the color difference components, Δh differed greatest between the cloths which were washed with the detergent solution at 20°C and at 40°C.

Soil removal

The higher the water hardness, the lower the soil removal, whether the detergent was added or not. The soil removal in the waters with a hardness of 60ppm or higher were negative values. From these results we can expect that as the water hardness becomes higher, more alkaline earth metals combine with the cocoa pigment. The metal complexes with the cocoa pigment evenly disperse in the washing liquor which does not contain detergent, and then these complexes are adsorbed again on the cloths. In the 250ppm hard water, the soil removal of the cloth which was washed with detergent at 20°C was much lower than that at 40°C. In the soft water, however, the soil removal of the cloth which was washed at 20°C was almost the same as that washed at 40°C.

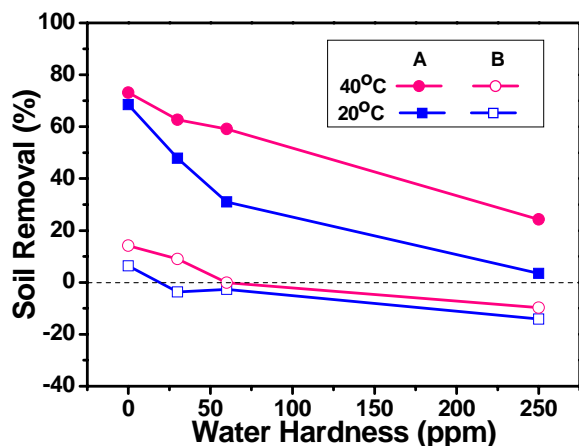


Fig.1. Soil removal of cocoa soiled cloth washed in the various hardened water. (A : with detergent, B : without detergent).

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