Influences of Mordants on Silk Dyeing with Color Extracted from Branches of Apple (*Malus pumila var dulcissima*)

Yuko KOBAYASHI

Nagano-ken Junior College, 49-7 Miwa 8-chome,

Nagano, 380, Japan

(Received September 30, 1989)

ABSTRACT

Dyeing of silk with color extracted from branches of apple has been carried out by the method used in a general handcraft dyeing. With the view of giving a scientific examination to that, in this report, the influences of color concentration and of mordant metal were examinated. The color differences of dyed silk cloths were measured on a color difference meter.

The brightness of color of dyed cloth was decreased with the increase of concentration of dyestuff, and the values were equilibrated above 500% o. w. f.. The influences of kinds of metal (Al, Cr, Cu, Fe, and Sn) on color were remarkably observed. From 50% o. w. f. of dyestuff the color differences were observed, and beyond 500% o. w. f. these came up to constant.

In the dyeing of silk with the extracted dyestuff from apple branches, various series of color are available by the combination of the dyestuff concentration and the kind of mordant metal.

INTRODUCTION

Natural materials have been attracted attention from various fields of study. In the field of dyeing, the herb dyeing has been well received and natural dyestuff come to been received a better attention. Scientific substantiations of natural dyestuff are necessary to generalize the dyeing of higher utility and commercial value.

Dyeing as an artistic handcraft using bark of apple tree is not so popular[1)~5)]. The reason for which an apple tree is unusual dye is that there are few literature dealing with the dyeing method and no investigation was reported on the dyeing property. Racent years, natural coloring materials and ancient hue are of interest as trendy color. So the fundamental data such as safety of natural dyestuff, simple dyeing method and dyeing property are significant.

In this report, the dyeing properties of color extracted from apple branches (*Malus pumila var dulcissima*) are investigated using silk fiber.

EXPERIMENTALS

1. *MATERIALS*

The apple branches harvested at Ueda city in february 1989 were used as coloring material. The silk cloths (KANEBO FUJIGINU NO. 5080) were used after the destarch and refining treatment by a conventional method. The size of silk cloth used in the following experiments was 10×10cm and its average weight was 0.70g.

As mordant reagents copper acetate Cu $(CH_3COO)_2 \cdot H_2O$, iron sulfate $Fe_2(SO_4)_3 \cdot nH_2O$, potassium alum $AlK(SO_4)_2 \cdot 12H_2O$, tin chloride $SnCl_4 \cdot nH_2O$ and potassium dichromate $K_2Cr_2O_7$ were used of analytical grade without further purifications.

Ion-exchanged distilled water was used in the following experiments.

2. *METHOD*

(a) Extraction of color from apple branches

The apple branches were cutted into small pieces by cutter knife and dipped into ion-exchanged distilled water. The extractions at boiling temperature were done for 30 minutes. This extractions were repeated three times exchanging water for same pieces of apple branches. After the filtration of the extracted solution, the dyeing solution was prepared by mixing three solutions.

Because of color change due to oxidation the extractions of coloring materials were done before each experiments.

(b) Dyeing of silk cloth

Silk cloths were dyed in the following procedure; dyeing (for 30 minutes)—washing by water—mordant treatment (for 20 minutes)—washing—dyeing (for 30 minutes)—washing—drying in air. The bath ratio in the dyeing procedure and mordant treatment was 1:71.4.

Thermostated shaking water bath (TOKYO RIKA KIKAI. NTS-211) was used in the dyeing and mordant processes. The shaking speed of the flasks was controlled at 90 r.p.m..

First, the influences of the concentration of dyestuff were examined. The amounts of apple branches were changed as 50%, 100%, 200%, 500% and 1000 % o.w.f.. In these experiments the concentration of mordant was kept at 3 % o.w.f.. The temperature was raised from room temperature to 85°± 1°C for 15 minutes and at this temperature dyeing was continued for 30 minutes.

(c) Measurement of color difference

Silk cloths dyed in these experiments were ironed out wrinkles and measured color difference on a color difference meter (NIHON DENSHOKU ND-101DP).

One plot of these results was the average from at least four samples, and at least three different points were measured for one sample, and the diameter of measurement point was 30 mm.

RESULTS AND DISCUSSION

Almost coloring materials obtained from plants belong to mordant dyes. These dyes were bound fast in fibers by the mordant treatment forming metal complexes[6)7)]. The degree of dyeing power is not so high in the dyeing without mordant reagent. The metal complex formation is seemed to raise the dyeing fastness.

Silk fiber is formed by protein and is the amphoteric fiber having amino group and carboxyl group at terminal as significant dyeing points.

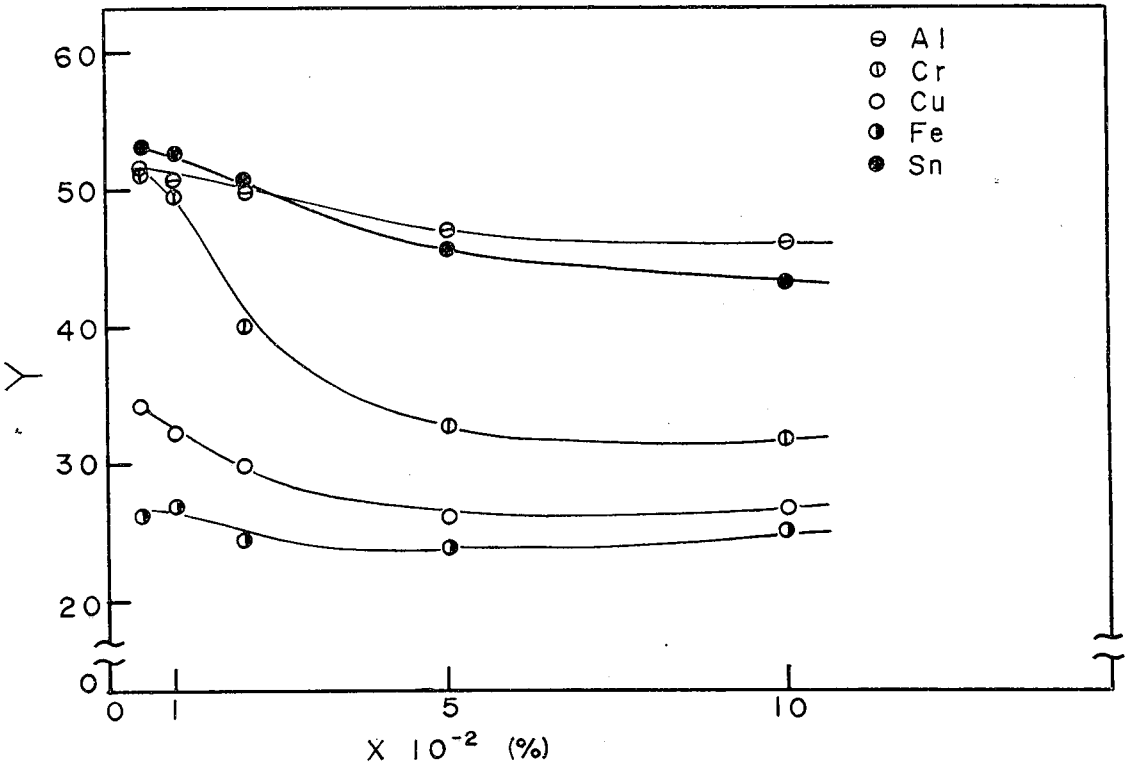

Figure 1 Relations between Y value of color difference of dyed silk cloths and concentration (o. w. f.) of dyestuff extracted from apple branches: [mordant metal]=3.0% o. w. f..

Figure 1 shows the change of Y values of color difference measurements against the concentration change of dyestuff. Mordant metals are Cu, Fe, Cr, Al and Sn, and the concentration of these were kept constant at 3.0% o. w. f. in the following all experiments. Y values were decreased with the dye concentration, and reached

constant above 500% o. w. f. of dye concentration, regardless of kinds of mordant metal. The degree of decrease of chrome was most rapidly.

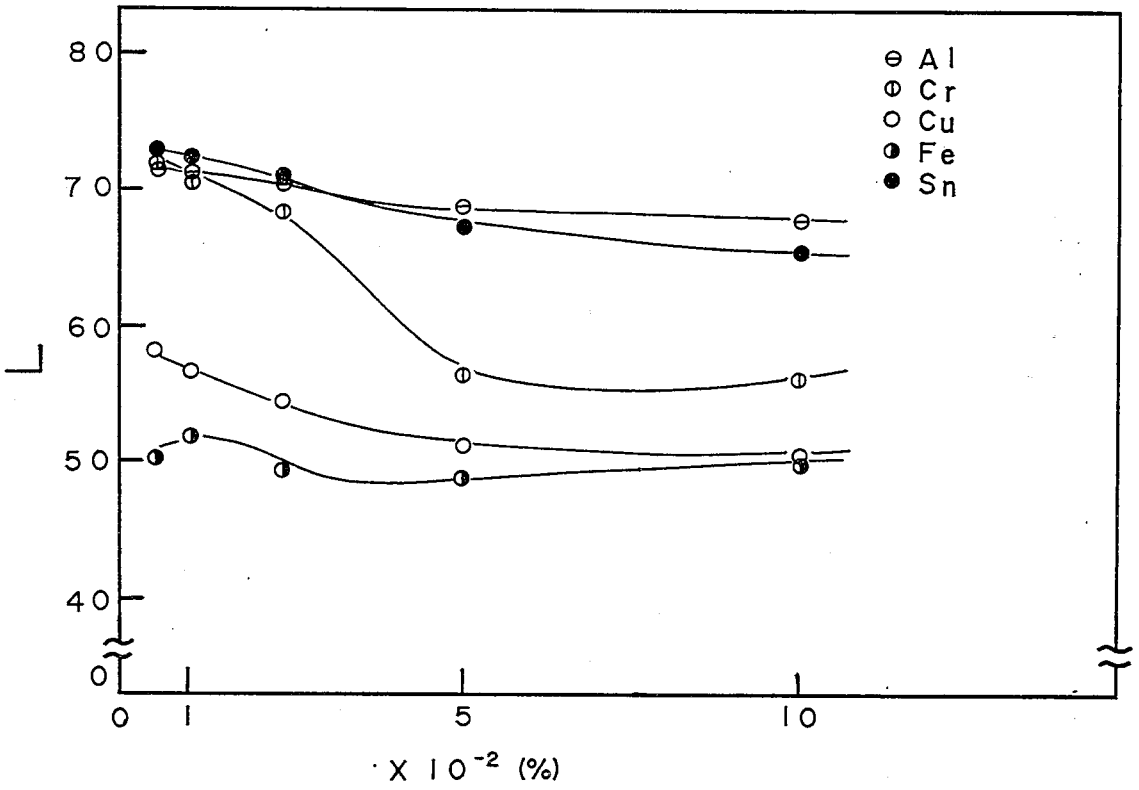

Figure 2 Relations between L value of color differences of dyed silk cloths and concentration (o. w. f.) of dyestuff extracted from apple branches: [mordant metal]=3.0%o. w. f..

Figure 2 shows the change of **L** values of the same samples shown in Figure 1. At both figures these values decreased in order of Al>Sn>Cr>Cu>Fe. The brightness of color was most widely changed at chrome.

The amount of apple branches above 500% o. w. f. did not change the color brightness, and the control of color brightness was possible in the region of dyestuff concentration from 50% to 500% o. w. f..

Figure 3 is the chromaticity diagram with **a** and **b** values of dyed silk cloths. The **a** and **b** values of undyed silk cloth were 0.1 and 1.4 respectively. At tin and aluminium mordant, the increase of **a** was in exess of that of **b**. The increase of **a** at chrome is scarcely observed up to 200% o. w. f., and above this point **a** and **b** increased rapidly. At copper **b** values exhibited almost no increase with the increase of dye concentration. From this chromaticity diagram it was confirmed that quite a few of colors were available. Available hue was colors from yellowish green to creamy brown and yellowish red.

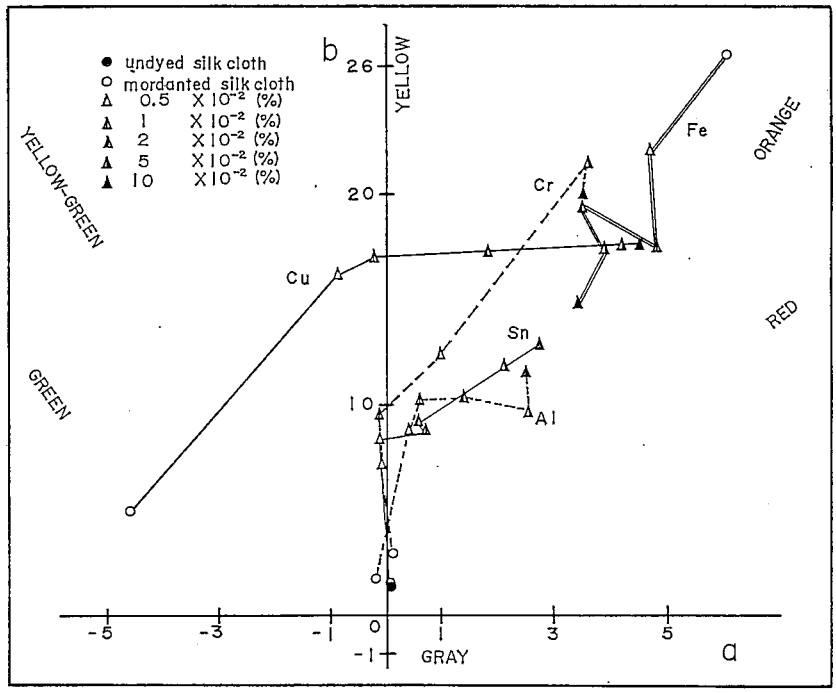

Figure 3 **L a b** chromaticity diagram of silk cloths dyed with dyestuff extracted from apple branches.

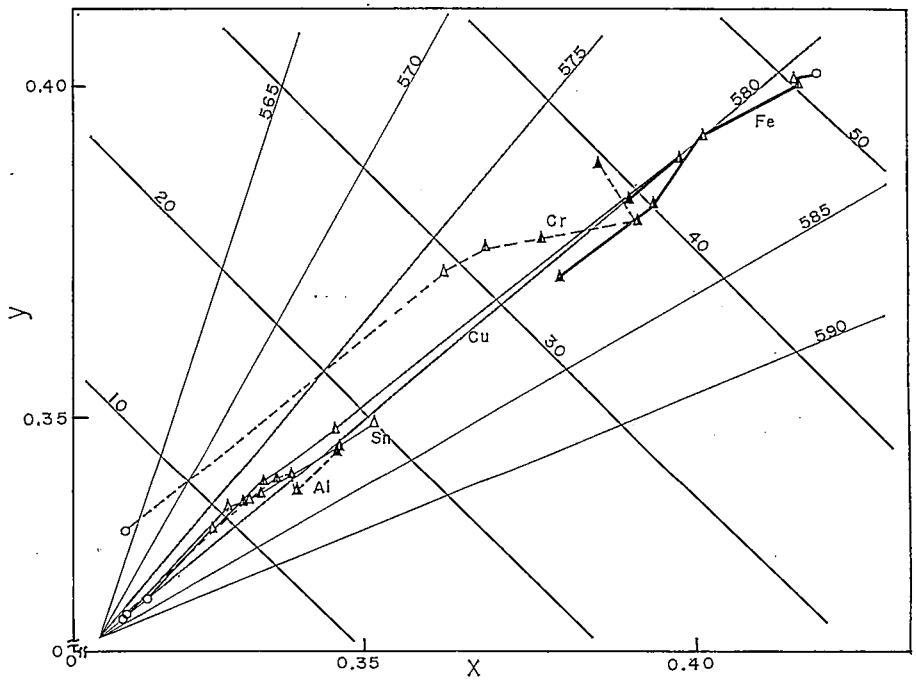

Figure 4 XYZ chromaticity diagram of silk cloths dyed with dyestuff extracted from apple branches.

Figure 4 is the XYZ chromaticity diagram expressing hue and chroma. All values of XYZ converged into the area of dominant wavelength from 575 nm to 585 nm. Extensive change in hue was observed at copper with the increase of dye concentration. Chrome and iron exhibited the change of chroma, and the excitation purity at iron fell down.

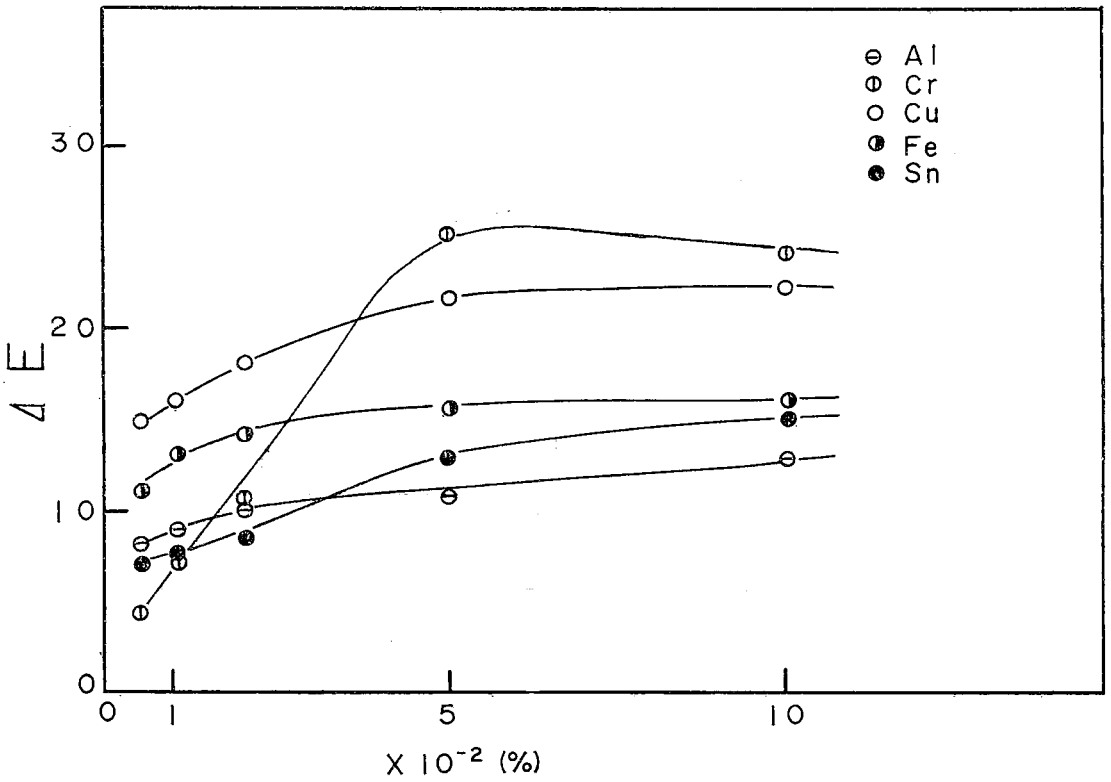

Figure 5 Relations between ΔE of dyed silk cloths and concentration (o.w.f.) of dyestuff extracted from apple branches: [mordant metal]=3.0% o.w.f..

Figure 5 shows ΔE change of silk cloths dyed with the color extracted from apple branches. ΔE is calculated from (1) equation.

$$\Delta E=[(L_1-L_2)^2+(a_1-a_2)^2+(b_1-b_2)^2]^{1/2} \qquad (1)$$

L, **a** and **b** values of undyed silk cloth were used as L_2, a_2 and b_2 in (1) equation respectively. The values of ΔE based upon undyed silk cloth increased in the order of Cr<Sn<Al<Fe<Cu, and its of Cr exhibited precipitous increase.

In conclusion, as shown in Figur 3, in the dyeing of silk with the extracted dyestuff from apple branches various series of color are available by the combination of the dyestuff concentration and the kind of mordant metal.

ACKNOWLEDGMENTS

The author wishes to thank Professor K. Mita, Nagano-ken Junior College, for performing the color difference measurement, and is grateful to the students belong to "Senshoku Seminar" for the assistance in the preparation of this paper.

REFERENCES

1) S. Goto *et al*: "Senryo Shokubutsu-fu", kyoto Shoin, P. 217 (1972)
2) T. Itakura *et al*: "Genshoku Senshoku Dai-jiten", Tanko-sha (1977)
3) M. Miyagawa *et al*: *Osaka-shiritsu Daigaku Seikatsu-kagakubu kiyo*, **28**, 87 (1980)
4) R. H. Thomson: "Chemistry and Biochemistry of Plant Pigiments", P. 597 (1977)
5) H. Somekawa: *Senshoku kogyo*, **21**, 424 (1973)
6) G. Back and H. Zollinger: *Helf. Chim. Acta*, **42**, 1553 (1959)
7) G. Back and H. Zollinger: *ibid*, **42**, 1539 (1959)