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산성화학약제의 처리가 생사의 물리적 성질에 미치는 영향

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The Effect of Acid Chemicals on the Physical Properties of Raw Silk

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Summary

This experiment was carried out to determine the effect of acid chemicals namely, sulphuric acid, formic acid and acetic acid on the physical properties of silk especially on tenacity and elongation which are the two most important properties in handling and processing of silk. The following results were observed.

It was recognised that there was a significant change in elongation in all the samples tested using the three different chemicals. In the test with acetic acid, the elongation at 40°C at pH 3 had a significant change.

Change was observed in the test with sulphuric acid at 40℃ pH 3 and in the case of formic acid test, there was a significant change in the elongation of raw silk at 80℃.

The above results qualifies earlier findings and studies that recorded that acids like formic acid and other organic acids could have an effect on the physical properties of silk.

Introduction

The application of acid on silk for bleaching, dyeing and scouring in order to bring out the good attributes that make silk highly prized as a material for clothing has increased over the years.

In 1862, Nicholson sulphonated aniline blue, and this became the first acid dye, since then, acid dyestuff have become popular for use on silk due to their direct affinity towards protein fibres, most of the acid dyestuff are chosen for the colour than placing too much emphasis on their other properties.

In 1988 Kozo Yasuda[15] utilised carboxylic acid in his study conducted with a view of selecting an effective protective agent for high temperature dyeing of silk, the result indicated changes of tenacity and elongation and degree of coloration of the treated

silk yarns, the strength of the treated silk yarn gradually started to decrease above the temperature of 110°C and also the elongation decreased rapidly with the rising temperature. The silk colour became yellowish.

The chemistry, technological properties of silk fibres have been studied by Lucas et. al. and Abderhalden and their 1958 review deals with many aspects of the chemistry, technical, physical and mechanical properties of silk as well as the structure of silk.

In sharp contrast to the large amount of work that has been carried out on the primary and secondary structures of various silks, comparatively little work has been done on the chemical reactivity of silk and its reactivity to acid chemicals. Hydrolysis action of oxidizing agents, resins and dyestuff with silk have been studied by a variety of authors.

In 1959, Huber and Luca et al[20]. made early surveys of silk processing, they reported that organic acids have little effect when used in dilute solution of formic acid at ambient temperature can cause dissolution of the fiber at higher concentrations.

Most of the studies that have been carried out on acids and silk fibers are linked with viscosity measurements and solubitity tests to determine the degree and efficiency of degradation. N--O peptidye or acl shift.

In 1952, Elliott[4]used concentrated sulphuric acid on silk fibroin and found by the Van Slyke method that 62% acly rearrangement of series peptide bonds had occured.

Previous studies indicate that nitric acid not only degrade the fiber but bring about peptide fission and also cause nitration of phenyl residues in the fiber and this causes discolouration in degraded silk.

Research also shows that in scouring with acids, the tensile properties of raw silk increases when the percentage of scouring loss is higher and that compression properties of the fabric increases when the percentage of scouring loss reaches 10%.

Other investigations showed that sulphuric acid and acetic acid when added to dyebaths, the temperature should be kept at 40°C to 80°C and not be allowed to the temperature for this is not without deleterious effect upon the tensile strength and lustre of the fiber.

Most of the information and studies concerning raw silk reactivity to chemicals can be derived from technical investigations into the chemical and physical properties of midified silk prior to industrial process.

The lack of interest in investigation further the raw silk chemical reactivity, its physical and chemical properties, may well be due to the decline in the commercial importance of the fiber, and with the advent of regenerated and synthetic fibers the raw silk qualities could be matched at a far cheaper cost and as a result the importance of the fiber had declined.

It is important to the note that silk is still used for high quality items and that its importance as a textile fibre still lay in its sheen, handle and draping qualities. These qualities as well as other physical properties especially tenacity and elongation play an important role in silk fiber relating to processing and practical usage of silk.

Although research records indicate that acids such as sulphuric acid and hydrochloric acids disolve silk, contracts the fiber length and mases it lose lustre, and no further damage is done, caution should be taken in the usage of these chemicals.

Records also show that nitric acid produces a bright yellow colour on silk with strong sulphuric acid silk swells and becomes a gelationus mass, and that formic acid and acetic acid have no injuries effective on silk unless heated.

However, with the increase in the use of acid dyes, and the use of acid for weighting, bleaching and scouring, caution should be taken if we are to preserve and maintain the long appreciated physical properties of silk, the so called queen of textiles. With this view in mind, the present study was carried out with an objection to investigate the effect of acid chemicals on the physical properties of silk.

Materials and Method

1. 1988 spring raw silk was used in this study
2. Chemicals
   A. Acetic acid(CH_3CHOOH) 0.1N
   B. Sulphuric acid H_2SO_4 0.1N
   C. Formic acid HCOOH 0.1N
   D. Distilled water
3. Split plot design was used for statistical analysis
   Control distilled water 40℃, 80℃
   Main plot(temperature) 40°C, 80°C
   split plot(pH) 3.0, 4.0, 5.0, 6.0

Diluted acetic acid, sulphuric acid and formic acid were put in separate 1000ml beakers and the different pH values were adjusted using pH meter, Philips-U. K. Three replications were performed at temperatures 40℃ and 80℃, the pH value at each application was carefully adjusted and the temperature in the hot bath was controlled, using an automatic temperature control bath.

Samples of 400 metres skein of raw silk were put in 1000ml separate beakers containing diluted sulphuric acid, formic acid and acetic acid. The beakers were then placed in a bath in anautomatic temperature control at controlled temperatures of 40℃ and 80℃ for 60 minutes. The solution in each beaker had an adjusted value ranging pH 3, pH 4, pH 5, and pH 6. The control experiment was carried out using distilled water at 40°C and 80°C at the same period of time as the chemically treated samples. After 60 minutes the samples were removed from the solution and rinsed with distilled water, they were then left to dry at room temperature.

The dry raw silk samples were then tested for tenacity and elongation at the Textile Technology Promotion Institute in Taegu Korea. Using the Instron UTM 111-500. Tokyo Baldwin Co. Ltd., at 2.54 cm. Each sample thread was tested ten times the tests were performed carefully to ensure specific results.

Results and Discussion

Table 1, shows the effect of acid chemicals applied on the raw silk. The effect on tenacity is shown in table one and the effect on elongation is shown in table two.

The data expressed in both table 1, and table 2, ,represent an average result of all samples that were tested at different pH meters and different temperatures 40℃ and 80℃ for 60 minutes in an automatic temperature control bath. In the two tables, we can observe that elongation of raw silk is lower in most cases as the pH value of 3.0, in samples tested with sulphuric acid at 40℃ there is

Table 1. The effect of acid chemicals on the tenacity of raw silk

Chemicals	Temp.(℃)	Tenacity(g/d)			
		pH3	pH4	pH5	pH6
Sulphuric Acid	40	3.5	3.6	3.6	3.6
Sulphuric Acid	80	3.7	3.9	3.9	3.9
Fromic Acid	40	3.6	3.8	3.8	3.8
Formic Acid	80	3.7	3.7	3.9	3.9
Acetic Acid	40	3.6	3.7	3.8	3.8
Acetic Acid	80	3.4	3.4	3.6	3.6
D. W.	40	4	4	4	4
D. W.	80	4	4	3.9	3.9

Table 2. The effect of acid chemicals on elongation of raw silk

Chemicals	Temp.(℃)	Elongation(%)			
		pH3	pH4	pH5	pH6
Sulphuric Acid	40	14.5	14.6	14.9	14.9
Sulphuric Acid	80	14.1	14.5	14.6	14.6
Fromic Acid	40	12.7	12.4	13.7	13.8
Formic Acid	80	13.1	13.1	14.1	15.5
Acetic Acid	40	13.3	13.3	14.3	14.5
Acetic Acid	80	13.4	13.8	13.8	13.8
D. W.	40	15.5	15.5	15.5	15.5
D. W.	80	15.7	16.1	16.5	16.5

a significant change in elongation is indicated at 40℃.

Significant change is indicated in table 2, at 80℃ in the sample tested with formic acid. These results indicate that the tensil strength has not been significantly affected but that the elongation is affected by spplication of acid chemicals. This is to say regardless of the temperature, acids could affect the elongation of raw silk, as the changes in elongation indicated in table 1 and 2 show changes at both temperatures 40℃ and 80℃. But the effect is more on the lower pH value.

Fig. 1 shows the effect of acetic acid on the physical properties of silk, specifically, tenacity after 60 minutes at 40℃. In this figure the tenacity has no significant change. The tenacity before treatment was 3.94g/d at 40℃ and 3.98g/d at the same temperature

after treatment. At 80°C which is also indicated in Fig. 1 the tenacity shows no significant change too, as the g/d before treatment was 3.75 g/d and 3.98 g/d after treatment. At both temperatures, treatment was made at different pH values, 3, 4, 5 and 6. No significant change is shown in both cases.

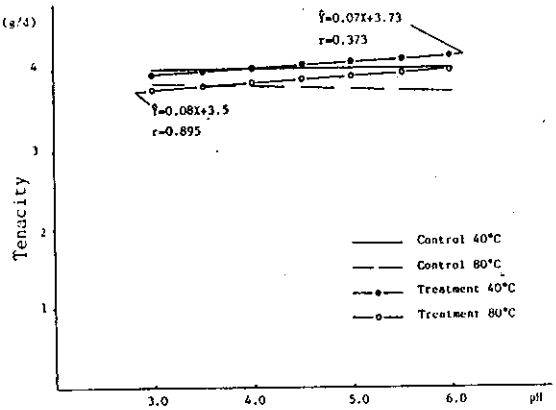

Fig. 1. The effect of acetic acid on tenacity of raw silk

Fig. 2 shows the effect of acetic acid on the elongation of raw silk, at 40℃ and 80℃ for 60 minutes at different pH values. Before treatment the elongation can be observed by the control which has an average elongation of 16.2% at 80℃ and 15.5% at 40℃. However, after treatment the elongation at pH 3 which was 15.23% at 40℃ and 14.06% at 80℃, there was an indication of significant change in the elongation at 40℃ to 16.16% there was no significant change at any pH at 80℃. This is to say that the acetic acid had an effect on the elongation of raw silk.

The effect of sulphuric acid on the physical properties of silk.

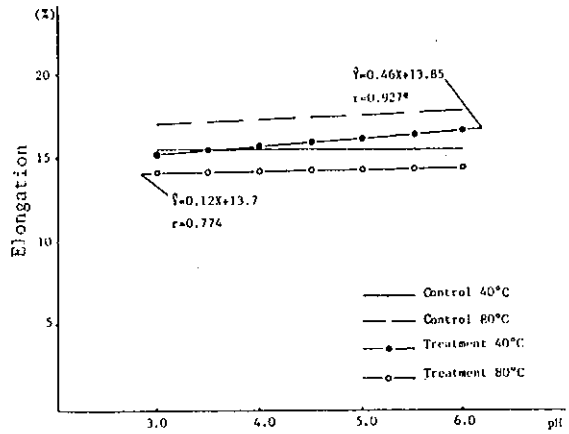

Fig. 2. The effect of acetic acid on elongation of raw silk

Fig. 3 shows the effect of sulphuric acid on the tenacity of raw silk at different pH value at 40℃ and 80℃ for 60 minutes. The tenacity at pH 3.0 at 80℃ was 3.7g/d and at 40℃ was 3.5g/d, at 6 pH the tenacity shows 3.6 at 40℃ and 3.9 at 80℃. There was no significant change in both cases and in different pH values. This is to say sulphuric acid had no significant effect on tenacity of raw silk.

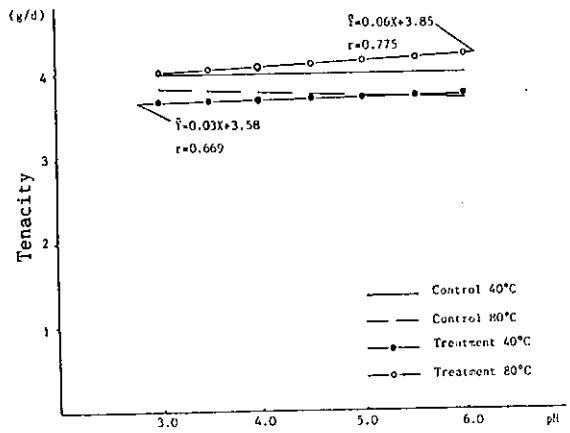

Fig. 3. The effect of sulphuric acid on tenacity of raw silk

Fig. 4 shows the effect of sulphuric acid on the elongation of raw silk according to different pH value at 40℃ and 80℃ for 60 minutes. At oG 3 the elongation was 14.5% at 40℃ and at 80℃ was 14.1%. At pH the elongation at 40°C was 14.9% and at 80°C it was 14.6%.

There was no significant change in the elongation at both temperatures and different pH value, this indicates that sulphuric acid had no significant effect on raw silk.

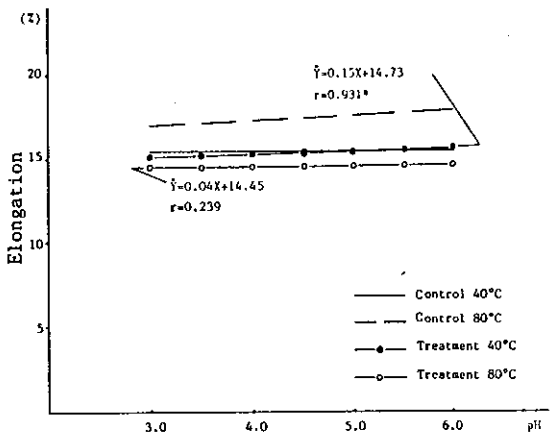

Fig. 4. The effect of sulphuric acid on raw silk elongation of raw silk

Fig. 5 indicates the effect of formic acid on the tenacity of raw silk at 40℃ and 80℃ at different pH value for 60 minutes. At 40℃ tenacity at pH 3 was 3.93g/d and at pH 6 shows 4.11 g/d at 80℃ at pH 3, tenacity shows 3.93 and 4.11 at 6 pH. There was no significant change in tenacity at 80℃ and 40℃ at different pH values.

Fig. 6 shows the effect of formic acid on the elongation of raw silk at different pH value, at 40℃ and 80℃ for 60 minutes. At pH 3 elongation shows 15.26 at 80℃ and at the same temperature at pH

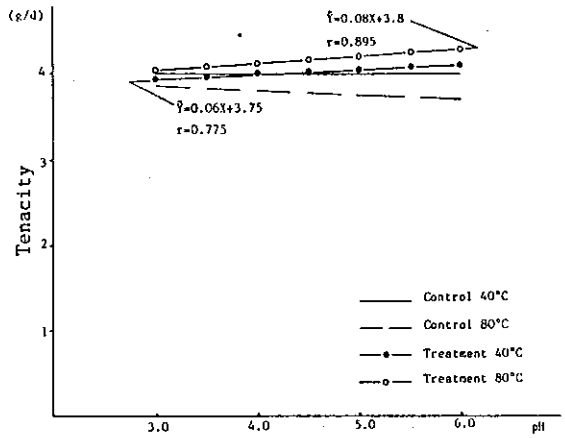

Fig. 5. Effect of formic acid on tenacity of raw silk

6 elongation is shown to be 16.82. At 40℃ the elongation is 14.53g/d at 3 pH and 15.91g/d at pH 6. There is a significant change in elongation at 80℃. This shows that formic acid had an effect on the elongation of raw silk.

This result qualifies previous studies that show were made by Huber and Luca et. al. in their 1958 report, in which they indicated that organic acids

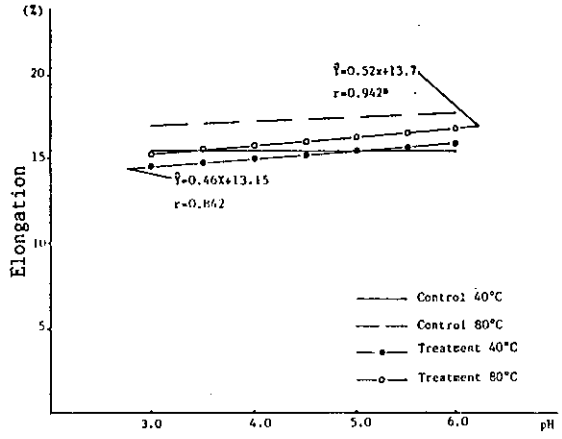

Fig. 6. The effect of formic acid on elongation of raw silk

could have effect when used in dilute solution at ambient temperature, could affect the fiber or even cause dissolution on the silk fiber. Other researchers also indicate that silk exhibits relatively good resistance to organic acids but that in the presence of strong acids its peptide chains break down in statistically distributed manner. Which leads to a rapid decline in the tensile strenth (DP fall). Serine and threonine are particularly sensitive to Acids.

The effectiveness of the aicd chemicals utilised was not due to the temperature however, the concentration of the solution caused more effect on the changes of the quality of raw silk in this case, the elongation of the raw silk.

적 요

본 실험은 견직물의 염색시에 많이 사용되는 Acetic Acid, Sulphuric Acid 및 Formic Acid등의 산성 화학약제 처리가 생사의 물리적 성질에 미치는 영향을 규명한 것으로서 그 결과는 다음과 같다. 생사의 강력(g/d)은 공시 3개약제 다같이 온도 및 pH 변화에 따른 차이를 인정할 수 없었다.

생사의 신도(%)는 Acetic Acid 및 Sulphuric Acid 40℃ pH 3에서 Formic Acid 80℃ pH 4에서 유의차 있게 저하되었다.

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