Effect of Temperature, Time and Concentration using an aqueous sodium carbonate for degumming of silk fibroin

Short Communication

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ABSTRACT

The degumming process carried out to modify and control mechanical and biodegradable properties of silk fibre, it is defined as key factor for silk fibre treatment. The main objectives of this study are to evaluate the effect of temperature, times and caustic soda concentration on losses and recovery of silk fibre. The aqueous solution of Na_2Co_3 was used; also the three reading for each (temperature, time and concentration)were taken. In order to evaluate the effect of each parameter on sciricn removed, one of these parameters should be variable and rest of parameters were kept constant. It has been obviously noticed the increasing of temp, aqueous concentration and time will increased the percentage of sericin removed. Result revealed that the effect of temperature on degumming loss percentage was higher at temperature range(60.70.80 and 90^0C) the losses percentage recorded were (18,21,28 and 35 respectively) comparable with the degumming loss obtained by the effect of aqueous concentration and time. The study also showed that, when the values of concentration (0.01,0.015. 0.02, 0.025g/l) and (20,25 30,35 min) were increased, the degumming loss were affected and increased linearly recorded values of (15,22,23,26) and (16,20,25,26) respectively. It is obviously noticed the optimum concentration, time and temperature which achieved higher sericin removed were (0.025g/l. 35 min and 90^0C, respectively).

Keywords: Silk fibers, degumming process, aqueous solution, serine. Weight recovers.

INTRODUCTION

Silkworm silk fibre produced from cocoon is a kind of most popular fibre because of its superior mechanical and biodegradable properties.

Sericulture is the production of Silk fibroin natural macromolecule generated by silkworm *Bombyx mori*. It is practiced by Chinese since 2200.B.C.This production was remaining secret for centuries but later it was transferred to be continental and widely used. Silk filament yarn is composite material consisted of two fibroin components surrounded by coated serecin layer (Zhou et al, 200). Silk material composed of 22 to 25% sericin m 62.5 to 67% fibrion, water and mineral salts. Fibroin is a single protein does not dissolved in water. Sericin is amorphous structure found on the fibre weightiness and whiteness causing it to be hard. Degumming is define as main process by which the Sericin will remove, the remaining of Sericin will affect silk properties such as softness and drape of fabric product. Various techniques was applied to remove or to minimize the sericion on silk. The alkaline bath was mostly used to remove sericin using alkali and soap some time the synthetic detergents was used instead of soap.(Freddi et.al, 1996). Aqueous silk fibroin solution is prepared by dissolving silk fibriob in the concentrated neutral salts (Yuji et.al, 2005). The optimum and suitable parameter process such temperature concentration and time should be carefully adjusted in order to avoid fibre degradation which caused unpleasant appearance such as poor handle and uneven dyestuff. Silk degumming required huge amount of water and energy, beside that it has an environmental impact of effluent(Freddi et. Al, 2003).Resent studies reported that, the protein enzymes, acidic, processes have been used as degumming agents (Gulrajani et.al, 2000). It was found that the mechanical properties of tussah silk are affected by degumming time due to the change of fibre structure and fibroin alignment. (Hoet.al,2012). Study conducted by (Wang and Guom2001) reported that m the optimal technical parameters of silk degumming were the concentration of anhydrous sodium carbonate 2%m heating 60 min and path ratio 1:30.

MATERIALS AND METHODS

Silk cocoon were obtained from local farm located at Blue Nile State, while chemical compound used was purchase from Sigma Company. Silk fibres were conditioned for 48 hour prior to testing under ($20+2^0$C and 65+2 RH %) condition. The aqueous was prepared by dissolving one gram of Na_2 Co_3 into 100 ml of water these component were heated to $70C^0$. Weight of 1.40 gram of raw silk fibre was impregnated into aqueous solution for 25 minutes. To study the effect of concentration the treatment repeated three times, the time and temperature were kept constant. Meanwhile the concentration of Na_2 Co_3 was changed (0.015, 0.02 and 0.025 respectively). Also in order to evaluate the effect of temperature, the four reading of different temperatures was taken (60, 70 80 and 90 C^0)at the same time the concentration and time were kept constant. Finally the effect of different time wad study by using ranging of time (25, 30 and 35 min) on other hand temperature and concentrations were kept constant.

Degumming loss:

It is process of calculating the efficiency of degumming the formula used to estimate the degumming loss after treatment is given below.

Degumming loss(%). = [(initial wt of silk cocoon –wt of silk fibroin recovered)/initial wt. of silk cocoon]× 100

RESULTS AND DISCUSSION

Effect of time on silk degumming:

In order to evaluate the effect of time on removal sericion from silk product the aqueous concentration and temperature were kept constant. Meanwhile the time was changed accordingly within the range of 20-50 min. Table (1) shows the degumming loss increased linearly, at 20. 30 , 40 and 50 min respectively) degumming loss was reach 16.20,25 and 26 percent respectively) . The maximum degumming loss obtained at 50 min. It has been reported by (Sah and Pramanik, 2010) more time will lead to increase solubility of sericine into solution and probably exposed Sericin to the action of hydrolysis by salt.

Table (1) Effect of time on degumming and weight losses of silk fibrion

Time (min)	Weight (g) before treatment	Weight (g) after treatment	Losses(%)
20	1.4	1.17	16
30	1.4	1.12	20
40	1.4	1.05	25
50	1.4	1.03	26

Effect of aqueous concentration on silk degumming:

To study the effect of salt concentration on the amount of sericion removed the temperature and time were remain constant, while the concentration was change in the range (0.01-0.025g/l),the amount of concentration was kept as minimum as possible because the increasing of salt amount will make the solution harsh which affect the intact of fibre and fibre smoothness. It has been obviously noticed from the table (1). The amount loss percentage increased with increased of concentration. The result was agreed with study carried out by (Sah and Pramanik, 2010).

Table (2) Effect of salts concentration on degumming and weight losses of silk fibroin

Concentration(g/l)	Weight (g) before treatment	Weight (g) after treatment	Losses(%)
0.01	1.4	1.19	15
0.015	1.4	1.09	20
0.02	1.4	1.08	23
0.025	1.4	1.03	26

Effect of temperature on silk degumming:

To determine the effect of temperature on sericion removed, the concentration and time were kept constant while temperature was changed in the range 60-90^{0}C. It has been reported, that

the water used reduced amount of sericin into silk fibre but high temperature was required to increased amount of sericion removed (Sah et.al, 2010). It has been clearly noticed from table (3). The increased of temperature will increasing the amount of degumming loss linearly. The results were coincided with results reported (Sah et. Al, 2010).

Table (3) Effect of Temperature on degumming and weight losses of silk fibrion

Temperature ^{0}C	Weight (g) before treatment	Weight (g) after treatment	Losses(%)
60	1.4	1.15	18
70	1.4	1.1	21
80	1.4	1.01	28
90	1.4	0.91	35

CONCLUSION

The study revealed that the time, concentration and temperatures were affecting the amount of sericin removed from silk fibroin. The increased of three parameters were results in linear increased of degumming loss percentage. The optimum conditions for degumming time, concentration and temperature were found (50min,0,025g/l 90^{0}C respectively).The amount of salt concentration used was kept as minimum as possible. To enhance appearance and tensile properties of silk fibroin maximum amount of sericin should be removed. Based on the results the effect of temperature on degumming was higher comparable with effects of concentration and time parameters.

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أثر الحرارة والزمن والتركيز لمحلول كربونات الصوديوم على إزالة الصمغ من شعيرات الحرير

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تجرى عملية إزالة الصمغ للتحكم ولتحسين الخواص الميكانيكية والتحلل الاحيائي لشعيرات الحرير ، وهي من العلميات المفتاحية لمعالجة الحرير. إن الغرض من هذه الدراسة تقييم أثر درجة الحرارة وتركيز الصودا الكاوية والزمن على الفاقد من شعيرات الحرير. تم استخدام محلول كربونات الصوديوم ($Na_2 CO_3$) وأخذت ثلاثة قرأت لدرجة الحرارة والزمن والتركيز لتقييم أثر كل متغير على إزالة الصمغ ، لذا يتم تغيير واحد من هذه العوامل مع ثبات العوامل الأخرى. لقد تلاحظ وبوضح أن زيادة درجة الحرارة وتركيز المحلول والزمن يزيد من النسبة المئوية للصمغ المزال.

اظهرت النتيجة أن أثر درجة الحرارة على نسبة الفاقد من الصمغ عالية عند المدى (60، 70، 80، 90) درجة. وكانت نسبة الفاقد المسجلة هي (18 ،21 28، 35) بالترتيب.

اظهرت الدراسة أيضاً عند زيادة الزمن والتركيز (30،35، 25، 20) دقيقة و (0.02، 0.01،0.015 0.025g/L). فإن الفاقد في المادة الصمغية يتأثر ويزيد بصورة خطية وقد سجل الأرقام التالية وبالترتيب (26، 23، 22، 15) و(26، 25، 20،16). ومن الملاحظ التركيز ودرجة الحرارة والزمن الأمثل لإزالة كمية كبيرة من الصمغ هي (35min ،$90C^0$، 0.025 g/L) بالترتيب.

الكلمات المفتاحية:

شعيرات الحرير ، عملية إزالة الصمغ ، المحلول ، حامض السيرين الوزن المسترجع.