

Comparative study for role of using surfactants with enzyme in scouring and bleaching pretreatments of cotton fabrics

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Abstract

This paper discuss using (proteases, lipases and cellulases) enzymes in scouring process in addition to nonionic surfactants in a view to study the effect of the former on the role of enzyme in scouring process. The desized cotton fabrics were treated with enzymes and nonionic surfactants in order to obtain the best results of surfactants and enzymes, after that we study the treatment time to obtain the the best condition of desizing treatment. The best conditions of scouring process using to make comparison between (a) bioscouring (new method) and bleaching in one bath with traditional method (alkaline method), (b) bioscouring (new method) and bleaching in two baths with traditional method (alkaline method).

Introduction

Cotton is the most important fibres in textile industry , cotton used since old decades because of its properties – durability, easy wash , good strength, good moisture and wicking properties ⁽²⁾ .

Cotton is single cell fibre , Cotton consists of cellulosic and non -cellulosic material ^(7,8) , Non cellulosic is 4- 12% of the cotton fibre . the non cellulosic substances must be remove to prepare the fabric to the bleaching and dyeing , the processes A process of removing non-cellulose substances from cotton fibres is called scouring which followed by bleaching. The sodium hydroxide the most scouring agent that used in this processes ^(4,6,8) .

Bleaching is the process that destroy the colouring matter with the help of bleaching agents to produce white fabrics.

In order to reduce pollution and have green environment , enzymes is used in the scouring process without sodium hydroxide to reduce the harsh effect of the alkaline method ⁽¹⁾ .

Experimental Work

Materials and dyestuff

- 1) **Fabric:** pure cotton woven fabrics (157g/m²) (yarn count 20/1) from Nilen Textile industry.
- 2) **Enzymes:**
 - Protease , lipase produced by Jiangsu Boli Bioproducts Company located in 93 Yangzhou Road, china and used throughout this study.
 - Cellulase: enzymes produced by Advanced chemical processing company located in 10 of Ramdan and used throughout this study
- 3) **Surfactants** : noionic surfactants (chemical composition : Highly solid concentrated fatty easter condensate with emulsifier) was produced by Advanced chemical processing company and used throughout this study
- 4) **Dyes:** Reactive dye (reactive dye ME4BL 195) was produced Garima dye chemistry located in India

Methods

1- Scouring

Traditional method: the desized cotton fabric were scoured with 2 gm / L NaoH , 2 gm / L wetting agent , at 90 °C for , PH = 11 Time = 60 min

Effect of surfactants concentration : the desized cotton fabric were scoured with different concentration of surfactants (0.50%,1%,1.5%, 2%) with adding 1% enzymes (combination of proteases, lipases and cellulases) enzymes , L:R = 1: 20 , pH =7 at 50- 70 °C for Time = 60 min.

Effect of enzyme concentration : the desized cotton fabric were scoured with different concentration (0.50%,1%,1.5%, 2%) of enzymes (combination of proteases, lipases and cellulases) with adding 1% noionic surfactants , L:R = 1:20 , pH =7 at 50- 70 °C for Temp =60 °C .

Effect of treatment time : the desized cotton fabric were scoured with 1% surfactants ,2 % enzymes L:R = 1: 20 , pH =7 at 50- 70 °C for Temp =60 °C with different times(15, 30,45min,60 and 75 min)

2- Comparative study

Alkaline scouring : like the pevious method

Bioscouring the desized cotton fabric were scoured with 1% surfactants ,2 % enzymes L:R = 1: 20 , pH =7 at 50- 70 °C for Temp =60 °C with different times(30min)

Bleaching

the scoured cotton fabric were bleached with different concentration of hydrogen peroxide (1,2,4,6,8gm) with NaOH 2gm/l, Stabilizer 25 % of H₂O₂, L:R = 1:20 , pH =7 at 95°C for 60 min .

the **Comparative study will be between**

- 1) Alkaline scouring of the desized cotton fabric and bleaching with different concentration of hydrogen peroxide (1,2,4,6,8gm) in two baths
- 2) Bioscouring (new method) of the desized cotton fabric and bleaching with different concentration of hydrogen peroxide (1,2,4,6,8gm) , in one bath . the bleached cotton fabric were evaluated for

Measurements

Color strength :the color strength (K/S) of was determined according to color reflectance technique with a spectrophotometer, ultra scan pro (Switzerland)

This test method is designed for determining the color strength of fabric .

degree of whiteness: the degree of whiteness was determined according to CIE method EN ISO 105-J02:1997(E) standard using spectrophotometer, ultra scan pro (Switzerland)

This test method is designed for determining the whiteness degree of fabric .

wettability :the wettability was evaluated by measuring the wetting time according ^(3,5) to the AATCC method A drop of water is allowed to fall from a fixed height onto the surface of fabric under examination. The time that has been taken for the drop of water to disappear has been measured and taken as a wetting time. The results given are the average value of four readings.

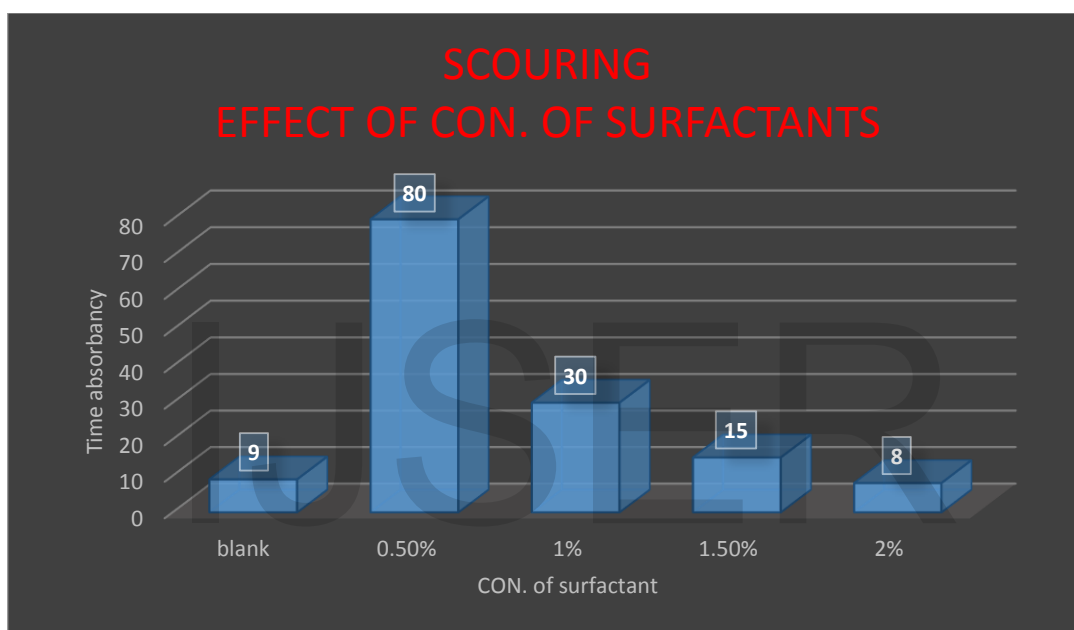
Breaking strength: the Breaking strength was determined according to the ASTM D 13934 – 1 : 2013 Standard Test Method for Determination of maximum force and elongation at maximum force Using the strip method

The method is mainly applicable for woven textile fabrics , including fabrics which exhibit imparted by the presence of an elastomeric fibre , mechanical or chemical treatment. It is not normally applicable to geotextiles , nonwoven , coated fabrics, textile glass woven fabrics , and fabrics made from carbon fibres or polyolefin tap yarns .

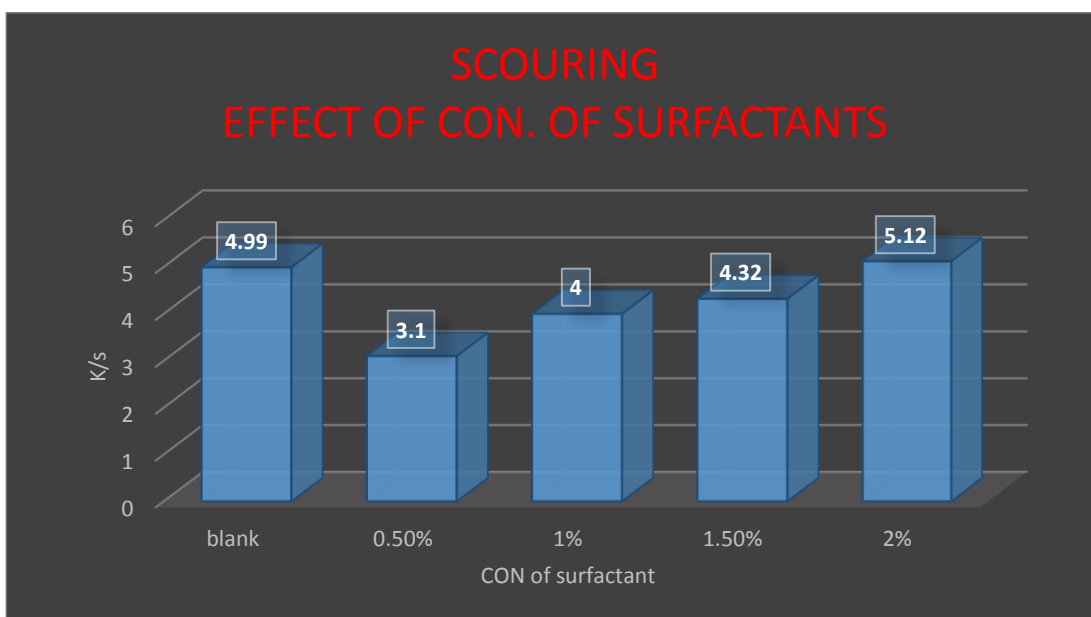
Result and discussion

I- Effect of surfactants concentration

In figures 1,2 : scouring fabric were scoured as discussed in the experimental section. . the Scoured cotton fabric were evaluated for a) water absorbency (Figure1) and B) K/S(Figure2)



(Figure1: Effect of nonionic surfactants concentration on water absorbency)



(Figure 2 : Effect of nonionic surfactants concentration on K/S)

The figure (1) illustrate that increasing the concentration of surfactants while the enzyme is constant accompanied by decreasing in time of water absorbency.

It is also clear that inverse proportional relation between the concentration of surfactant and time of water absorbency. It also found that the least time of water absorbency is 8 sec by adding 2% surfactants, 1% enzyme to the enzyme reaction. When comparing the new method and the traditional. It can be illustrated that the time of water absorbency is 8 sec by adding 2% surfactants, 1% enzyme (the new method) while the traditional way the time of water absorbency is 9 sec by using NaoH + wetting agent.

The decreasing in time of water absorbency indicate to the fabric is more wettability that refer to the scouring rate is getting higher

The decreasing in time of water absorbency refer to that the new pretreatment is more intensive than the traditional

Adding the surfactants to the enzymatic reaction is made some alteration in the reaction . the surfactants make a fabric more accessible to the enzyme by

- Movement the crystalline regions
- Reduce the surface active agent and attract the enzyme into the fabric.
- Open the the fibres to the enzyme

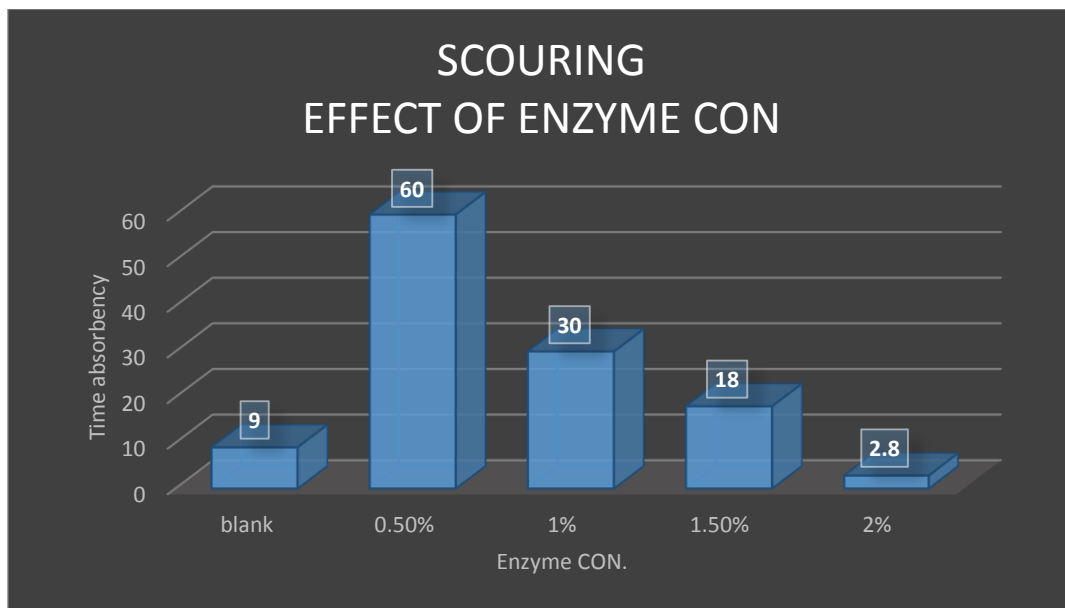
The figure (2) shows that increasing the concentration of surfactants while the enzyme is constant accompanied with increasing in k/S.

As the previous result the bioscouring is more efficiency than the traditional so that the bioscouring is made the fabric more wettability So the penetration of dyes in the fabric increase. and the whiteness of the fabrics is increasing so that the k/S increasing

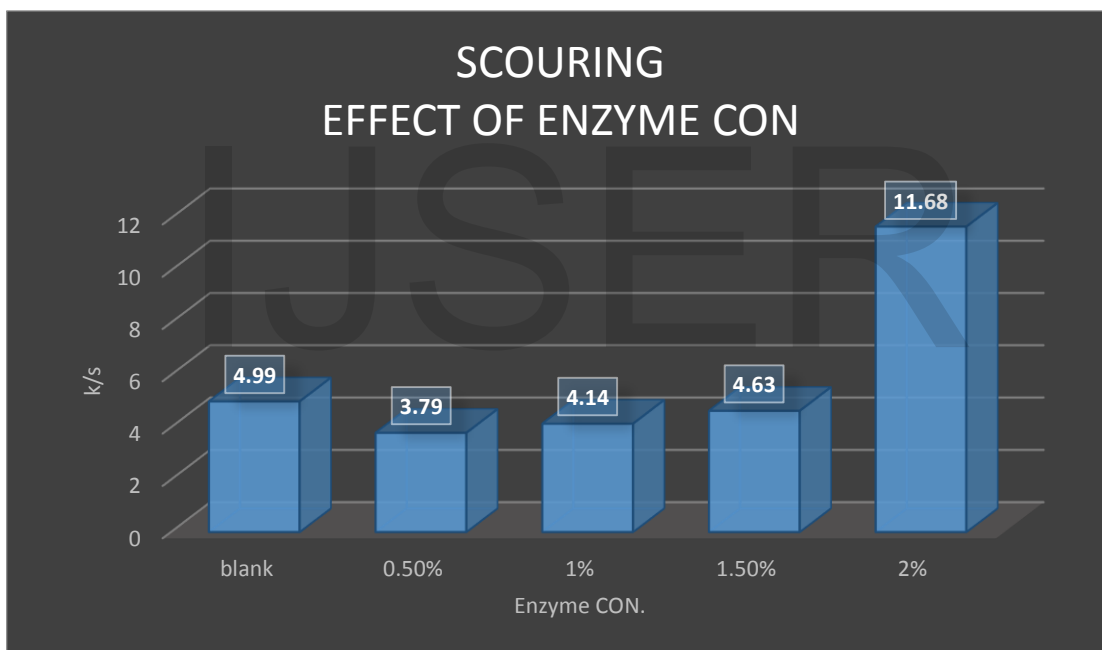
Another reason that the surfactants reduce the crystalline region and make the fabric more accessible for enzymes and others auxiliaries in processes (scouring, bleaching and dyeing) and so on the k/S is increase

II - Effect of surfactants concentration

In The figures (3,4) : scouring fabric were scoured as discussed in the experimental section. . the Scoured cotton fabric were evaluated for a) water absorbency (Figure3) and B) K/S(Figure4)



(Figure 3 : Effect of Enzyme concentration on water absorbency)



(Figure 4 : Effect of Enzyme concentration on K/S)

The figure (3) illustrate that increasing the concentration of enzymes while the surfactants is constant occurs a significant decreasing in the time of water absorbency on the fabric.

It is also clear that inverse proportional relation between the concentration of enzymes and time of water absorbency. It also found that the least time of water absorbency is 2.8 sec by adding 2% enzyme 1% surfactants to the enzyme reaction. When comparing the new method and the traditional that is illustrated the time of water absorbency is 2.8 % by adding 2% enzyme 1% surfactants (the new method)

and while the traditional way the time of water absorbency is 9 sec by adding 2% enzyme without surfactants.

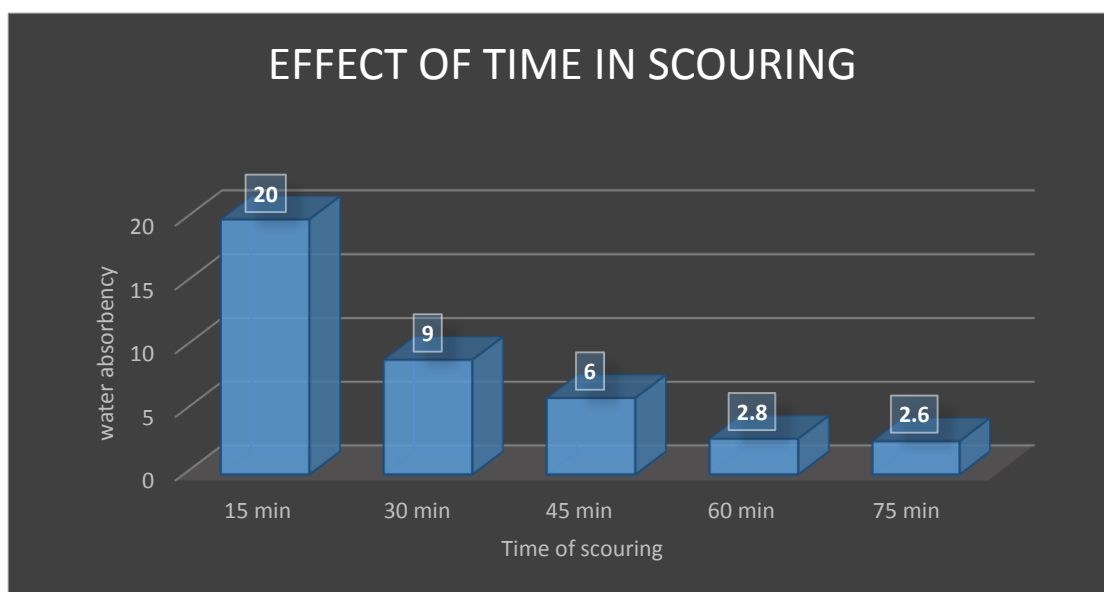
with the increase of enzymes concentration in scouring , scouring rate is getting higher. this is because in increasing the enzymes concentration that mean more enzymes penetrate into the fabrics and remove more impurities (like waxes proteins, and minerals) and thoroughly prepared for subsequent wet processing treatments such as, bleaching, dyeing, printing, or finishing by making the fabric more hydrophilic have effectively combined with the substrate. At this time increasing the concentration of the enzyme can only make the reaction rate double . The surfactants facilities the enzyme reaction like the previous method so by adding the surfactants the bio scouring is getting higher

The figure (4) illustrate that increasing the concentration of enzymes and the surfactants is constant occurs a significant increasing in the time of K/S on the fabric.

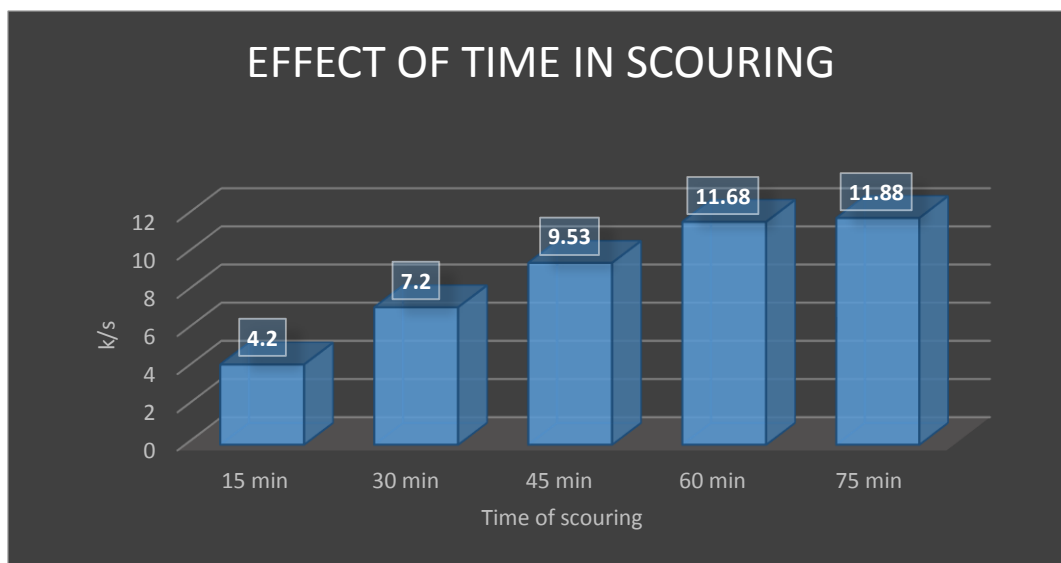
As the previous the with increasing the concentrations of enzymes scouring the scouring rate getting higher and the fabrics is more hydrophilic and the penetration of dyes and other auxiliaries getting higher and so on the k/ s increase .

III - Effect of time concentration

In The figures (5, 6) : Fabric were scoured as discussed in the experimental section. . the Scoured cotton fabric were evaluated for a) water absorbency (Figure1) and B) K/S(Figure2)



(Figure 5 : Effect of scouring time on water absorbency)



(Figure 6: Effect of scouring time on k/S)

The figure (5) illustrate that increasing time of scouring (using 1% surfactants and 2% enzyme) accompanied with decreasing the time of water aboserbancy until reach to 9 sec (during 30 min scouring) and 2.6 (during 75 min scouring) when compare that with the traditional method which used alkaline during 60 min to reach to 9 sec the time of water absorbency.

As the previous using the surfactants with enzyme was opened the fibre more and move the chains of the fibers making the fibers more accessible to the enzyme. And enhance the desizing treatment.

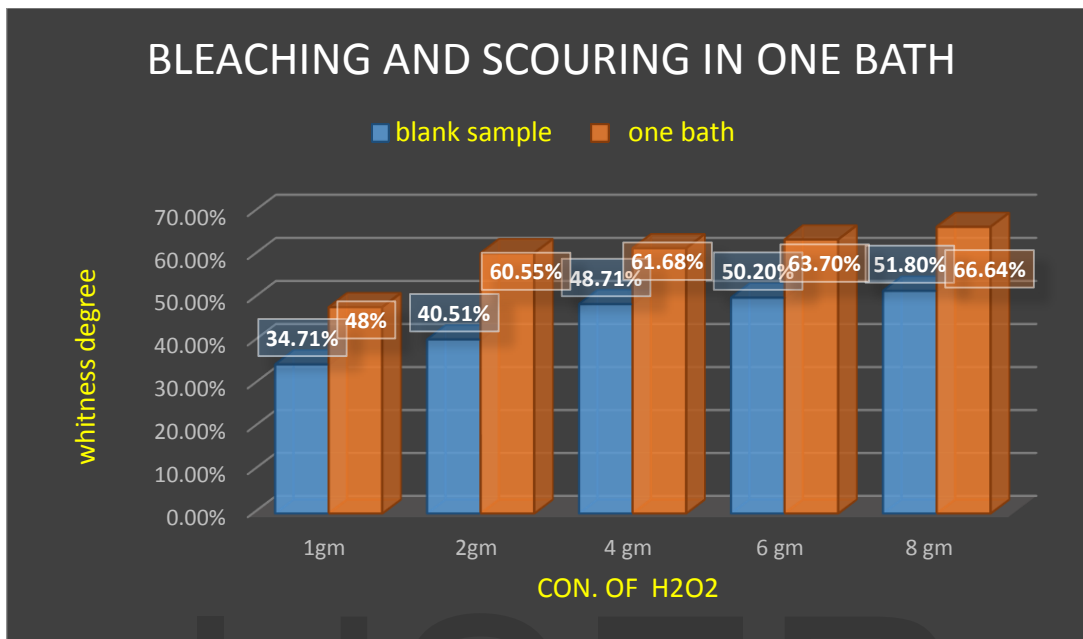
That meaning the new method can save 30 min than the traditional method and this is saving the time in the production process in the factory

The figure (6) illustrate that increasing time of desizing(using 1% surfactants and 2 % enzyme) accompanied with increasing the k/s

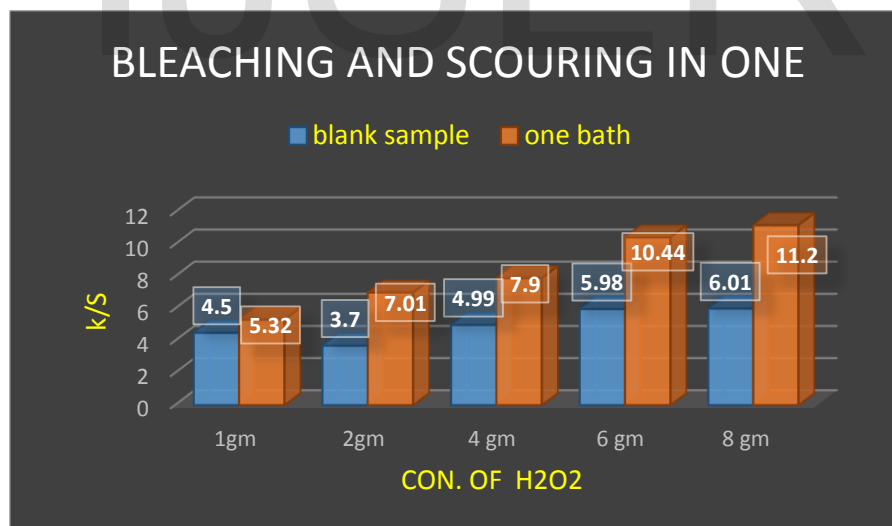
to reach to 7.2 (during 30 min scouring) and 11.88 (during 75 min desizing) when compare that with the traditional method which alkaline during 60 min to reach to 4.99 k/S sec the time of water absorbency . because that the scouring rate is higher so that the wettability and the whitness of fabric increase and so that the the colour strength increase

Comparative study (1) between

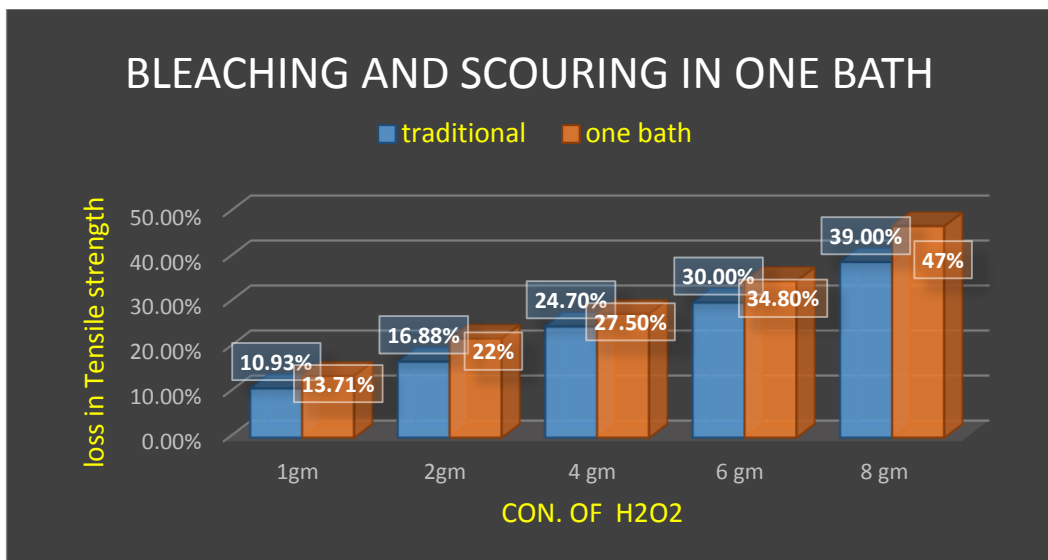
Fabric were scoured and bleached as discussed in the methods section.. the bleached cotton fabric were evaluated for a) whiteness degree (Figure 7) , B) K/S(Figure8), C) Tensile strength (Figure 9) , D) elongation (Figure10)



(Figure 7)Comparison in whiteness degree between one bath and alkaline method baths with different Concentration of Hydrogen peroxide



(Figure 8)Comparison in k/S between one bath and alkaline method baths with different Concentration of Hydrogen peroxide



(Figure 9)Comparison in Tensile strength between one bath and alkaline method Baths with different concentration of hydrogen peroxide

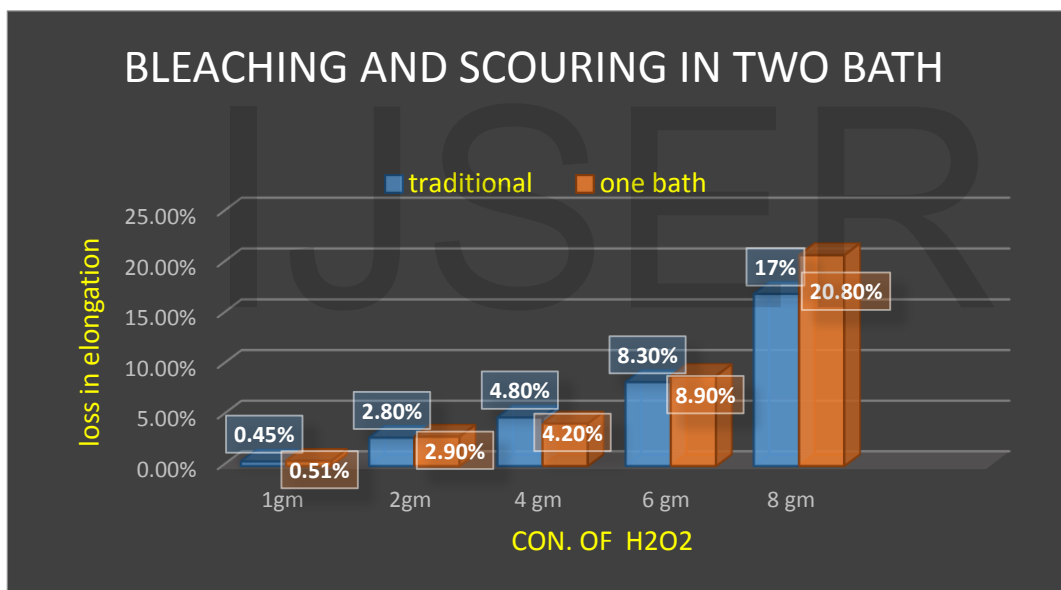


Figure10) Comparison in Elongation between one bath and alkaline method baths with different Concentration of Hydrogen peroxide

AS it clear from the data of figure (7, 8) that treating cotton fabric with different concentration of hydrogen peroxide is accompanied by increasing in whiteness degree and K/S . this phenomena holds true in all concentration of hydrogen peroxide (traditional method and one bath metod) It is also clear that their was a directly proportional relation between the concentration of hydrogen peroxide used and whiteness degree , K/S.

That meaning the whiteness degree in the new method higher than the

traditional with 15% . In the new treatment we save water, energy and chemical consumers. this benefits can be acceptable to apply the new method in the industry

This phenomena due to , two different explanations

After bioscouring process, the cotton fibres swelled, that became smoother and clean of non-cellulose impurities and the degree of whiteness increased. The fibres become more intensive and removes some of the coloured substances.

With increasing concentration of hydrogen peroxide that mean more molecules of hydrogen peroxide penetrate the fabric and the bleaching is getting higher

This phenomena due to , two different explanations

after bioscouring process, the cotton fibres swelled, that became smoother and clean of non-cellulose impurities that mean the colour after dyeing will be more pure . With increasing concentration of hydrogen peroxide that mean more greyness colour of fabric is been destroyed and the whiteness degree of fabric increased and that mean more molecules of dyes penetrate into the fabric and K/S increased.

The figure (7,8) illustrate with using 2 gm of hydrogen peroxide in one bath treatment the whiteness degree reach to 60.55 % and k/S 7.01. using 8 gm of hydrogen peroxide in traditional treatment the whiteness degree reach to 51.2 % and k /S 6.01. That is observed the whiteness degree of one bath treatment higher than whiteness degree of traditional treatment. So when using 2 gm of hydrogen peroxide in one bath treatment whiteness degree higher than whiteness degree with using 8 gm in traditional method.

In this case the factory can apply the one bath method. Because in the one bath treatment we save hydrogen peroxide, save water and keep the environment clean

The figure (9.10) that treating cotton fabric with different concentration of hydrogen peroxide is accompanied by increasing in loss in tensile strength and elongation in one bath and alkaline treatment. . this phenomena holds true in all concentration of hydrogen peroxide in one bath and alkaline treatment. It is also clear that their was a directly proportional relation between the concentration of hydrogen peroxide used and, increasing in loss in tensile strength and elongation in all ranges studied .

With increasing concentration of hydrogen peroxide. The whiteness degree was increasing that mean more concentration of hydrogen peroxide destroy the original colours of fibers by breaking down the hydrogen bond and so on the fiber became weak. So the tensile strength and elongation is decrease

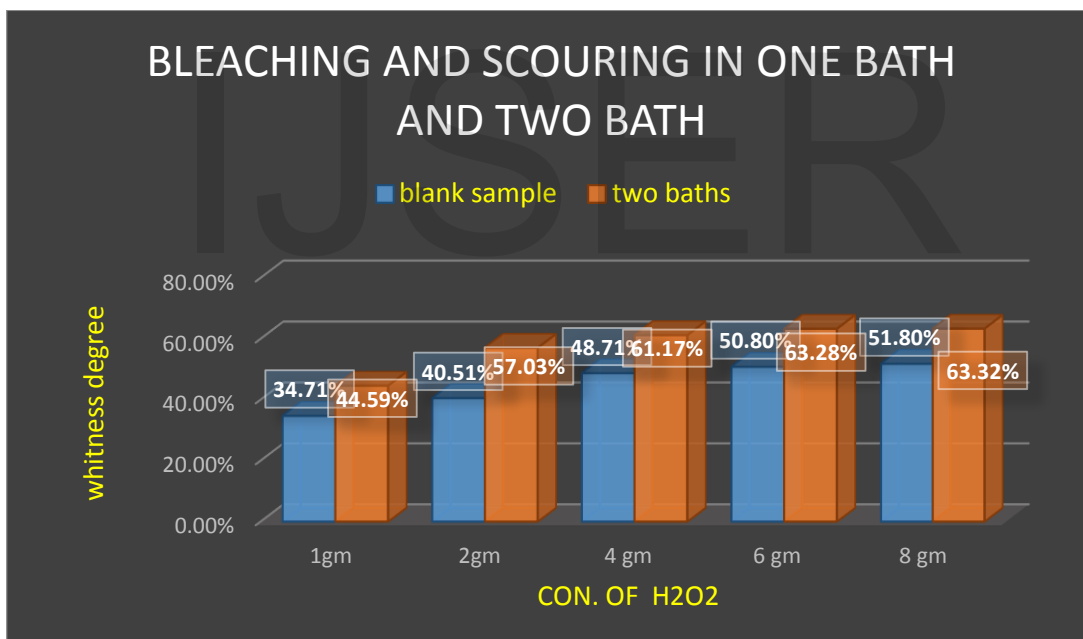
The figure (9,10) illustrate with using 2 gm of hydrogen peroxide in one bath treatment loss in tensile strength is 22 % and loss in elongation is 2.9 % (the

whiteness degree is 60.55 %). using 8 gm of hydrogen peroxide in traditional treatment loss in tensile strength is 39% and loss in elongation is 17 % (the whiteness is 51.2 %). That is observed the whiteness degree of one bath treatment higher than whiteness degree of traditional treatment . So when using 2 gm of hydrogen peroxide in one bath treatment , we obtain whiteness degree higher than using 8 gm in traditional method. But the tensile strength with using 8 gm of hydrogen peroxide in traditional method is decrease to reach to 39 %. With comparing this percentage with one bath, the tensile strength with using 2gm reach to 22 %

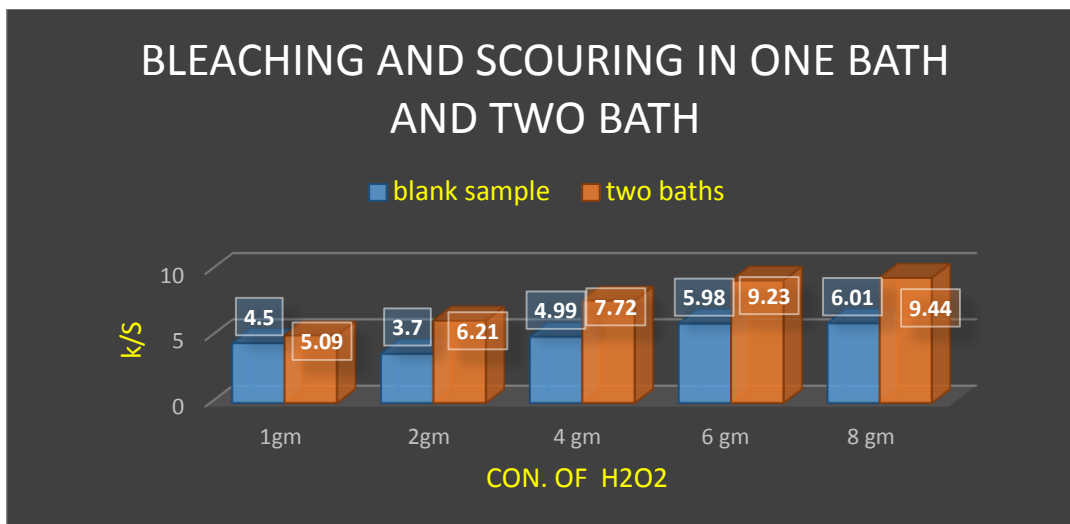
In The figures 11, 12,13,14: make comparison between

- Alkaline scouring of the desized cotton fabric and bleaching with different concentration of hydrogen peroxide (1,2,4,6,8gm) ,
- bioscouring of the desized cotton fabric and bleaching with different concentration of hydrogen peroxide (1,2,4,6,8gm) , in two baths

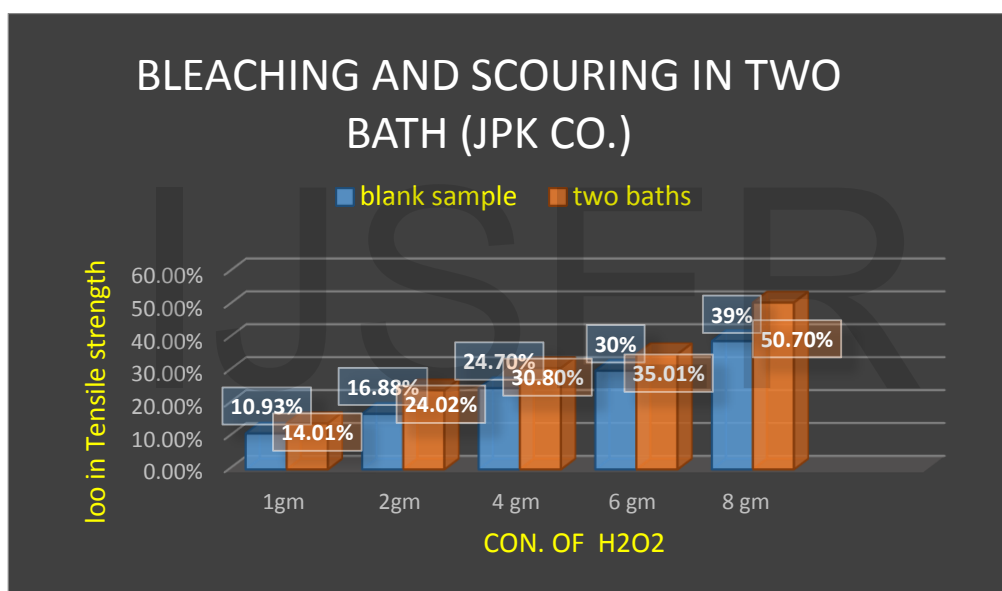
the cotton fabric were evaluated for whiteness degree (Figure11),K/S(Figure12) Tensile strength (Figure 13) , (elongation Figure14)



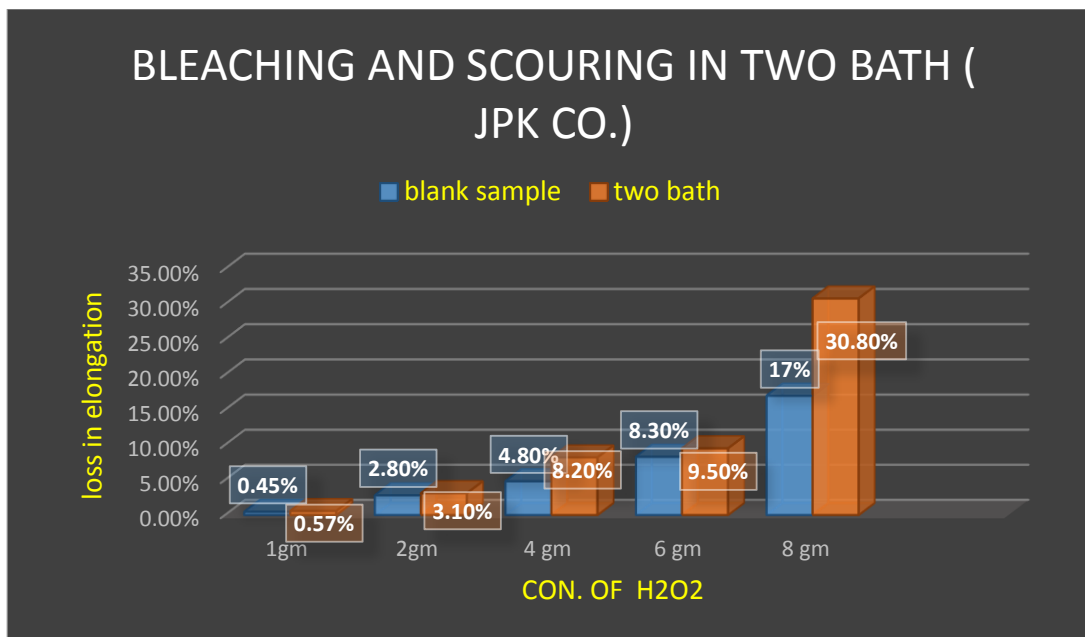
(Figure11)Comparison in whiteness degree between two baths and alkaline method with different Concentration of Hydrogen peroxide



(Figure12)Comparison in k/S between two baths and alkaline method with different Concentration of Hydrogen peroxide



(Figure 13)Comparison in Tensile strength between two baths and alkaline method with different Concentration of Hydrogen peroxide



(Figure14) Comparison in Elongation between two baths and alkaline method with different Concentration of Hydrogen peroxide

The figure (11) compare between two different treatment (two baths and traditional treatment)with different concentration of hydrogen peroxide and its effect on whiteness degree of fabric . AS it clear from the data of figure (11) that treating cotton fabric with different concentration of hydrogen peroxide is accompanied by increasing in whiteness degree . this phenomena holds true in all concentration of hydrogen peroxide (traditional method and one bath method) It is also clear that their was a directly proportional relation between the concentration of hydrogen peroxide used and whiteness degree. by increasing concentration of hydrogen peroxide the whiteness degree increased in all ranges studied . It also found that the highest whiteness degree was 63.32 % by using 8 gm / L hydrogen peroxide in bleaching reaction. When comparing the new method and the traditional one . It can be illustrated that the whiteness degree is 63.32 % by using bioscousing without surfactants and 8 gm / L hydrogen peroxide in bleaching process (the new method) while in the traditional way the whiteness degree is 51.64 % by using alkaline scouring and 8 gm / L hydrogen peroxide in bleaching process.

That is due to in two bath we using nonionic surfactants with enzymes in scouring treatment and this opening the fibres more and more make the fabric more accessible to auxiliaries in bleaching .

The figure (12) that treating cotton fabric with different concentration of hydrogen peroxide is accompanied by increasing in K/S . this phenomena holds true in all concentration of hydrogen peroxide (traditional method and one bath method) It is also clear that their was a directly proportional relation between the concentration of hydrogen peroxide used and increasing in K/S , by increasing concentration of hydrogen peroxide the k/s increased in all ranges studied . It also

found that the highest k/s was 9.44% by using 8 gm / L hydrogen peroxide in bleaching reaction. When comparing the new method and the traditional one . It can be illustrated that the k/s is 9.44 % by using bioscousing without surfactants and 8 gm / L hydrogen peroxide in bleaching process (the new method) while in the traditional way the whiteness degree is 6.01% by using alkaline scousing and 8 gm / L hydrogen peroxide in bleaching process.

Like the previous using nonionic surfactants with enzymes make the fabric more accessible to auxiliaries in bleaching and dyes so the whiteness degree is increased and so on the k/S of fabric increase .

The figure (from 11 to 14) illustrate with using 2 gm of hydrogen peroxide in two baths the whiteness degree reach to 57.03 % ,k /S 6.21, loss in tensile strength is 24.02 % and loss in elongation is 3.10 % . using 8 gm of hydrogen peroxide in traditional treatment the whiteness degree reach to 51.2% and k/S 6.01 loss in tensile strength is 39 % and loss in elongation is 17 % That is observed the whiteness degree of two baths treatment higher than whiteness degree of traditional treatment. So when using 2 gm of hydrogen peroxide in one bath treatment , we obtain whiteness degree higher than using 8 gm in traditional method. And tensile strength is better than in the two baths treatment.

Conclusion

Role of using surfactants with enzyme in scouring and bleaching pretreatments of cotton fabrics were studied. Measuring wettability and whiteness degree after scouring and bleaching pretreatment showed that Using the nonionic surfactants with enzymes increase the wettability after scouring and whiteness degree after bleaching .

Comparative study between bioscousing ,bleaching in one bath and alkaline method showed the one bath indicated to the best result in whiteness degree, k/s. application the one bath save the water and keep the environment clean.

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