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A study on the enzymatic degumming on silk fabric using *Carica papaya* skin

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Abstract
Enzymatic degumming involves proteolytic degradation of sericin using specific protease which does not attack fibroin. The main sources of protease are bacterial, fungal, plant and animal origin. In this study, an attempt has been made to synthesize protease enzyme from *Carica* papaya skin after degumming the sample was dyed with natural dyes. It is evaluated for the suitability in degumming of silk fabric. The degummed samples were subjected to subjective evolution such as whiteness, luster and appearance and comfort properties were also carried out.

Keywords: degumming, protease enzyme, silk fabric, natural dyeing

1. Introduction
Textiles is a vast field ever growing with the improvement in the field of science and technology Silk is a natural protein fibre, some forms of which can be woven into textiles1. Silk, the Queen of Textiles is a splendid gift of nature. The unique properties of silk like the natural sheen, inherent, affinity for dyes vibrant colour, high absorbance, light weight, resilience, and excellent drape have made it highly sought after it has been utilized for apparel for centuries2. Degumming is the process of removing the sericin, a sticky substance produced by the silkworm that holds the strands of silk together. It is also known as silk scouring3. Removing the gum improves the lusture, colour, and texture of the silk. As much as one-third of the weight may be lost when the gum is removed. Raw silk with the gum still on the filament is called 'Hard silk'. Degummed silk is 'soft silk'. Silk degumming can also be accomplished by treated with different alkaline, neutral and acid proteases (Enzymes) 4. Degumming of silk is traditionally carried out with soap or alkali which was not uniform in quality, the strength loss is high and also the chemicals used cause environmental pollution. It is therefore, desirable to replace them by the eco-friendly alternatives and in this respect, the enzyme play a key role. The action of enzyme can be controlled to avoid strength loss but at the same time obtain uniformly degummed silk. Enzymatic degumming involves proteolytic degradation of sericin using specific protease which does not attack fibroin 3. The degummed silk fabric was dyed with red sandal wood as a natural dye.

2. Material and Methods
2.1 Selection of material
Silk is the strongest protein fibre made by the silk worm larvae. Silk is often used to make cloth. The cloth can be made in to clothes, rugs, bedding 5. Four meters of raw silk fabric was purchased in Chennai for this study. Two meters of this was kept aside as original fabric. Remaining material was used for commercial bleaching and for papaya skin degumming.

2.2 Pretreatment of the silk fabric
Removal of the gum or sericin is termed as degumming Ritu agarwal(2000) [4]. Sericin is responsible for imparting a harsh and stiff feel of silk. It is essential to remove sericin.

2.3 Degumming of silk fabric
Commercial degumming
A detergent solution contains 0.5 ml per 100 ml of water was prepared.

The raw silk was dipped into the solution and stirred gently for 30 minutes at 50°C. It was squeezed in the soap solution and then rinsed under tap water till free from traces of detergent. After that fabric is dried partially.

2.4 Degumming by using papaya skin
For the degumming papaya skin was collected from the unripened papaya

2.5 Extraction of enzyme
The enzymatic silk degumming provides better results in the degumming process and also reduces the effluent. The proteolytic enzymes are soft on fibre and they hydrolyze the peptide bonds formed by amino acids. Protease is a class of enzymes that converts the complex proteins in to simple proteins6.

The latex of the papaya-plant and it's green fruits contains two proteolytic enzymes papain and chymopapain. 100 grams of papaya skin was grinded with 1000ml of water. Then the solution was filtered by filter paper and centrifuged to extract the protease.

2.6 Optimization of Degumming Parameters
1. Optimization of enzyme concentration for degumming

To optimize the source concentration, three different concentration of the extracted enzyme was taken in individual beakers with material liquor ratio as 1:10 and the concentrations as 10, 15 and 20 ml. The pH was maintained at 7 and respectively for 12 hours at room temperature. The silk fabric was dipped in to the beakers containing different concentrations of the source and degummed. After 12hours the degummed was fabric taken out and washed thoroughly with cold water and dried. The optimum source concentration was obtained by calculating the weight loss.

2. Optimization of time for degumming

Degumming of silk fabric was carried out under different time. To optimize the time for degumming, the enzyme was incubated at 35°C at pH 7 and different time intervals such as 6, 12 and 24 hours. After each incubation period the fabric was washed with cold water and dried.

3. Optimization of pH for degumming

The optimum pH for degumming was determined at different pH such as 6, 7, and 8 by keeping the temperature as constant at 35°C. The pH was adjusted using 0.1N HCl or 0.1N NaOH. Silk fabric was wet and dipped in to six beakers containing enzyme extracts at different PH. The degumming bath was incubated at 35°C for 6 hours. After the incubation period the fabric was washed with cold water and the weight loss of the dried yarn was obtained.

4. Optimization of temperature for degumming silk fabric

Silk fabric was immersed in to the optimum enzyme concentration at different temperature viz. 40ºC, 60ºC and room temperature. Degumming the silk yarn at each temperature with selected pH and time was done to obtain the best result. After the duration of time, the silk fabric was washed. The optimum temperature was selected based on the change in colour and maximum weight loss.

2.7 Enzymatic Degumming
Based on optimization the investigator select 1; 10 for concentration, time was 5 hours and temperature was room temperature. One meter of raw silk fabric is soaked for 5 hours in the solution of extracted protease. Then the fabric is rinsed thoroughly under tap water and dried.

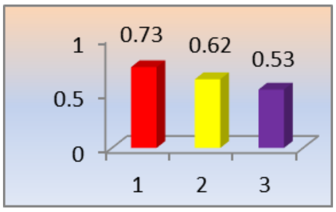
2.8 Selection and collection of the dye source
The natural dyes present in plants and animals are pigment molecules, which impart colour to the materials. These molecules containing aromatic ring structure coupled with a side chain are usually required for resonance and thus to impart colour. Red Sandalwood is also known as Red Saunders, it is used for natural dye. For use in incense, sandal wood can be a nice base which will add a red colour to your blend. The dry red sandal wood powder was purchased from khadhi shop and it was used as a natural dye source.

2.9 Selection of Mordanting
10grams of powdered red sandal was added in the boiling water and allowed to boil for 1hour the same temperature was maintained. Then the dye solution (plate-IV) was filtered with filter. mordants are substances which are used to fix a dye to the fibres. They also improve the take up quality of the fabric and help improve colour and light fastness. Alum is effective, easily available, safe to use and it is much less toxic than other metal mordants. Alum was selected as a natural dye for this study.

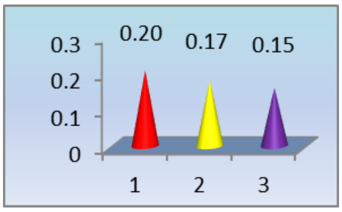
2.10 Simultaneous mordanting and dyeing
The both 2percent Alum and extracted dye solution were mixed together in stainless steel vessels in the liquor ratio of 1:10 20cms of enzymatic and commercial degummed silk fabric were dipped in to the dye bath and boiled for 30minute at 100°c. Then remove the fabric at 30 minutes and washed properly with clean water and then dried.

2.11 Evaluation of the Sample
The evaluation is very important in research. In this study selected raw silk fabric was commercial degummed, enzymatic degummed and natural dyed. The above said three samples such as original fabric, commercial degummed and dyed, enzymatic degummed and dyed were evaluated by visual inspection, physical properties, mechanical properties, comfort properties, wettability.

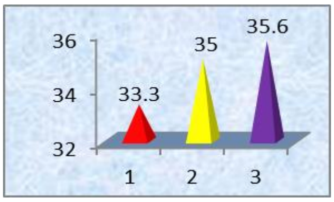
3. Results and Discussion
In the visual inspection, the enzymatic degummed and dyed sample C was rated as excellent in colour, evenness in dyeing, texture, appearance.



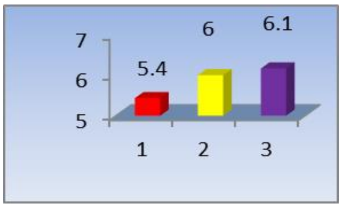
Fabric Weight



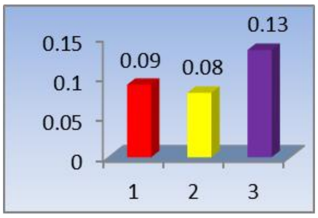
Fabric Thickness



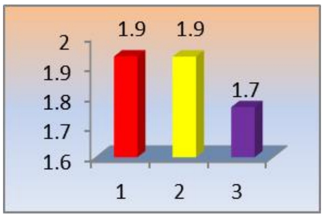
Tensile Strength



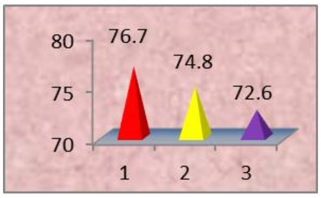
Elongation



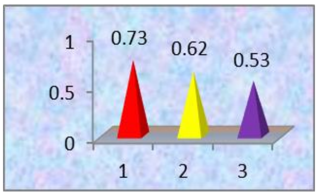
Abrasion Resistance



Fabric Stiffness



Fabric Drape



Crease Recovery

Figure 1

The fabric weight of the treated and untreated fabrics was evaluated by digital weighing balance. The samples B and C had significant decrease in weight about 15 and 27.7 percent than the original. The maximum weight has decreased by B and C samples due to Enzymatic and commercial degumming. Among all the sample C showed lowest weight when compare with all other samples.

The fabric thickness was decrease about 13.08 and 22.92 percent in B and C samples. After enzymatic degumming, when compared with original the C sample decrease in thickness about 22.92 percent due to removal of sericin.

The fabric strength along both weft and warp direction was evaluated by tensile strength tester. It was proved that all samples showed gain in tensile strength when compared with its original. The maximum gain was found in C sample.

The samples B and C have increased in elongation of 10.41 and 13.49 percent when compared with original. The mechanical properties evaluation such as tensile strength, abrasion resistance, and elongation were is higher in C sample due to enzymatic degumming.

The comfort properties evaluation such as stiffness, crease recovery, drape were evaluated higher. The maximum stiffness is found in a sample. The crease recovery and drape coefficient were higher in B and C samples. The maximum level of comfort is found in sample C.

An enzymatic and commercial degumming sample has gained its weight than original fabric. B and C samples gain its weight at 11.11 and 48.11 percent. C sample has 48.11 percent abrasion resistance.

The B and C samples had gain in stiffness along warp direction about 0.155 percent and 8.61 percent. C sample has gain maximum stiffness of 8.61 percent in warp direction. The C sample has maximum gain about 11.32 percent in stiffness along weft direction. The B sample also increased in stiffness about 6.86 percent. The maximum gain found in C sample about 11.32 percent when compared to its original.

The B and C samples has gain increase recovery along warp direction about 3.68 percent, 8.54 percent. Both dyed samples have significant gain increase recovery.

Higher the drape co efficient value shows lesser the drapability. All the treated samples such as B and C decrease in drapability about 2.51 and 5.41 percent respectively because of the degumming process increase the stiffness of the fabric.

The absorbency test shows B and C samples has gain absorbency than the original sample. The maximum was found in sample C. It was evident that enzymatic and commercial degumming improved the wet ability of the fabric.

4. Conclusion

From the summary of the results it can be concluded that enzymatic degummed and dyed fabric showed better results when compare with commercial degumming in physical, comfort and mechanical properties. The textile industry is the largest industry in terms of value, production and also in high effluent generation. There is a growing trend towards the application of highly specialized biocatalysts i.e., enzymes, for the chemical processing as well as for physio-chemical modifications of textile fibers. Enzymes being natural products and are completely bio-degradable and accomplish their work quietly and efficiently without leaving pollutants behind, so the enzyme concentration can be successfully used for carrying out the degumming of raw silk fabric.

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