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EFFECT OF ENVIRONMENTAL AND TECHNOLOGICAL FACTORS ON THE QUALITY OF COTTON FABRIC CLOTHES IN EGYPT

A Thesis

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ABSTRACT

Ecological problems and environmental protection are considered an international trend which emphasizes the use of eco-friendly clean technologies to produce eco-textiles.

True eco-textiles are defined as those which are bio-degradable and no hazardous or toxic substances are used in their production at any stage.

With the above in mind, the present work had two-fold objectives:

- To carry out the pretreatment of the loomstate cotton fabric using enzymes.
- To change the dyeing conditions using chemicals which are eco-friendly.
- To achieve the goal, the following studies were undertaken:
- Enzymatic treatments of cotton fabrics using different enzymes at a variety of conditions with a view to optimize treatments for bioscouring, biosingeing and biobleaching.
- The technical feasibility of bleaching using glucose.
- Evaluation of the physico-mechanical properties of the so treated fabrics monitoring loss in fabric weight.
- Results obtained indicate that the above treatments bring about cotton fabric with high wettability therefore high dye absorbency. Other properties are comparable to those for the traditional pretreatment.
- Dyeing of the enzymatically prepared fabrics with selected safe vat dyes was effected using glucose as reducing agent

instead of sodium hydrosulphite and other reductants which cause environmental pollution to partially fulfill Eco-dyeing.

- Eco-dyeing with selected vat dyes was fully achieved by using air, hydrogen peroxide or ammonium persulfate instead of ammonium dichromate and other oxidants which cause environmental pollution.

- Degradation of textile by environmental factors after exposed to weathering effects at an urban industrial site in Egypt. Thus, outdoor unprotected exposure for one set of all the examined samples was performed at Helwan city Egypt (A.R.E). Two groups of each fabric were used, the first group was exposed monthly to the prevailing conditions starting on May (2000) till April (2001) while the second one was exposed continuously for one year, Other similar samples were exposed in Alexandria.

Key words:

Cellulosic fabric, Enzymes, Biotechnology in textile process, vat dyes, Degradation of textile, environmental factors.

SUMMARY

Summary of (Chapter 1)

Today's pretreatment of cotton to eliminate non-cellulosics accompanying substances like waxes, proteins, pectins and hemicellulose uses a boiling-off process with concentrated caustic soda in presence of softners, complex builders, sequestering agents and reductants at 95^{o}C. This process results in: (i) high waste water load, (ii) auxiliaries used are usually not environmentally friendly from the environmental point of view. Now there is a search for alternative methods, such as the use of enzymes.

Also, the toxic conventional reducing agent, sodium sulfide as well as the oxidizing agent, potassium dichromate, have been replaced by more eco-friendly glucose-NaOH system as the green method during dyeing of vat dyes on cotton fabric.

Based on the aforementioned consideration, the present work comprises the following studies:

1- Use of different enzymes in the pretreatment processes (desizing, scouring and bleaching) and finishing instead of the chemical processes.
2- Physico-mechanical properties of the enzyme treated fabrics including tensile strength, wettability, stiffness and loss in fabric weight.
3- Effect of enzyme treatment on different cellulosic textile fabrics such as viscose/cotton blend, popline, drill and linen/cotton blend was studied.

4- Eco-dyeing by using non-pollutant technique for dyeing the cotton fabrics with vat dyes, this technique is based on the use of glucose/sodium hydroxide, as a safe reducing agent, instead of the toxic reducing agent (sodium hydrosulfite) in the reducing step of vat dye and,air, hydrogen peroxide or ammonium persulfate as a safe oxidizing agent for the vat dye instead of ammonium dichromate, sodium dichromate or other toxic oxidizing agents.

5- A comparison between the conventional treatment and the eco-friendly treatment.

Conclusions arrived at from these studies are given below:

(a) For application of enzymes in wet processing:

1- The non-cellulosics accompanying substances wax, pectin and hemicellulose are removed enzymatically from the desized cotton fabric using individual treatment with Bio-prip and Cellusoft L enzymes.

2- For a given set of bio-treatment conditions, the enzyme dosage up to 3% (owf) brings about a noticeable decrease in the fabric weight, tensile strength, stiffness and increase in the wettability.

3- The extent of bio-treatment increases by raising the reaction temperature up to 60^{o}C and 50^{o}C for Bio-prip and Cellusoft L enzymes, respectively, then decreases with further increase in the reaction temperature.

4- A significant enhancement in the extent of enzymatic activity is attained at reaction time from 15 to 60 minutes, then the extent levels off with further prolongation of time.

5- pH control is important from the point of getting the maximum activity of enzymes. The highest activity for the Bio-prip and Cellusoft L enzymes is achieved at pH 9 and pH 5 respectively.

6- When Denilite enzyme or glucose was used as bleaching agent for desized and scoured fabrics, the results obtained signify that:

a- A significant enhancement in the whiteness index and the weight loss is achieved by increasing the concentration of Denilite enzyme to 2% (owf) and glucose to 10 g/l.

b- Increasing the time and temperature has a positive effect on the physico-mechanical properties of the treated fabrics and increases the whiteness index; optimum temperature is 60^{o}C and 75^{o}C for Denilite enzyme and glucose respectively and the optimum time is 60 minutes.

c- pH 6 constitutes the optimal pH for best efficiency of the Denilite enzyme and the optimum pH for glucose bleaching bath is 13.

(b) For eco-friendly dyeing of cellulosic fabrics with vat dyes:

Based on the information of the above studies the loomstate cotton fabrics were enzymatically prepared. This was followed by eco-friendly dyeing using selected vat dyes which do not contain azo groups or triphenyl methane moieties which are carcinogenic and cause environmental pollution. Practices implemented along with their major findings are outlined under.

(Three)Bio-desizing with Kemylase enzyme, 2% concentration, for desizing of cellulosic fabrics.

(Four) Bio-scouring with Bio-prip enzyme, 1% concentration, for removing pectine from cellulosic fabrics instead of boiling the fabric with high concentration of NaOH, 40 g/l.

(Five) Bio-singeing (Bio-polishing) with Cellusoft L enzyme, 2% concnetration, for removing fluff and polishing of the cellulosic fabrics instead of using kerosene and mazot in burning the fluff aiming at reducing carbon fumes and consumption products which cause environmental pollution.

(Six) Bio-bleaching with Denilite and Denilite plus enzymes, 2% concentration, (1% denilite + 1% Denilite plus) instead of using sodium hypochlorite and sodium chlorite and other pollutant chemicals.

(Seven) Eco-bleaching of cellulosic fabrics with glucose, 15 g/l, as a safe and non-pollutant technique.

(Eight) Eco-dyeing with vat dyes as a safe dyes which do not contain any azo groups or triphenyl methane moieties which are carcinogenic and cause environmental pollution.

(Nine) Eco-reduction with Glucose L,H, British gum and Dextrine as a safe reducing agent to reduce vat dyes instead of using sodium hydrosulfite and other reducing agents which cause environmental pollution. This (use of glucose) gave high stability and successful safe reducing processes.

(Ten) Eco-oxidation with air, hydrogen peroxide and ammonium persulfate as safe oxidizing agents for vat dyes instead of ammonium dichromate, sodium dichromate and other toxic oxidizing agents which cause environmental pollution.

Factors affecting dyeing of celluosic fabrics with vat dyes were studied. These include:

British gum, Dextrin, Low reducing power Glucose L (37% dextrose equivalent), high reducing power Glucose H (52% dextrose equivalent), sodium hydrosulfite are different reducing agents which were used to transform dye to alkali soluble leuco form.It was noticed that high reducing power Glucose H (52% dextrose equivalent) is the best eco-friendly reducing agent with a reducing power nearly equal to that of sodium hydrosulfite. Followed by low reducing Glucose L (37% dextrose equivalent), dextrin, British g`1`1um respectively.For that reason, high reducing power Glucose H (52% dextrose equivalent) was used in the following experiments:

- Using the eco-friendly Glucose as areducing agent instead of the environmental pollutant sodium hydrosulfite in four ratios (Glucose: Dye), namely, 1:1, 2:1, 3:1 and 4:1. It was found that the ratio 4:1 (glucose: dye) is the best ratio to change the dye to its alkali soluble leuco form to be absorbed by the cellulosic fabrics.

- Using four different caustic soda: dye ratios, namely, 1:1, 2:1, 3:1 and 4:1. It was found that the ratio 4:1 (caustic soda: dye) is the best ratio which is suitable to transform the dye to its sodium salt which is absorbed by the cellulosic fabrics.

- Using different temperatures during dyeing process, these were, 45^{o}C, 65^{o}C, 75^{o}C, 85^{o}C and 95^{o}C. It was found that the best temperature for dyeing process is 75^{o}C, it is economic and gives the highest K/S.

- Different times for dyeing process were used, these were, 5, 15, 30, 45, 60, 90 minutes. It was found that the best dyeing time was 30 minutes which is economic and enough to give the highest K/S.

- Using different oxidizing agents to oxidize the dye and transform it to the insoluble leuco form inside the fabrics after the dyeing process. The following oxidizing agents were used: air, hydrogen peroxide, Borax, sodium dichromate , ammonium per sulphate and ammonium dichromate . It was found that the safest and most eco-friendly of these agents are hydrogen peroxide, ammonium per sulphate and air. They give color intensity near to that of the toxic ammonium and sodium dichromate which are environmentally pollutants.

- Using different dye concentrations, namely, 1%, 2%, 4%, 6% and 8%. The highest color intensity was achieved by using dye concentration of 4%, above this concentration, the fabrics become saturated with dye, minimum increase in the color intensity was noticed whatever the increase in dye concentration was.

- Using eco-friendly bioscouring, by firstly biodesizing with Kemylase enzyme followed by using Bio-prip enzyme to remove pectin from cellulosic fabrics. It was noticed that color intensity follows the order: viscose/cotton fabrics > Drill fabrics> Linen/cotton fabrics> popline fabrics.The color intensity values of these fabrics were close to the color intensity values of the fabrics scoured with caustic soda.

- Using the ecofriendly method for desizing with Kemylase then removing pectin and impurities with Bio-prip enzyme, then

bleaching with Denilite enzyme and another bleaching with glucose. It was found that the bleaching with Denilite enzyme is better than bleaching with glucose. However, the color intensity of the dyed fabrics bleached with glucose is higher than those bleached with Denilite enzyme. The color intensity was similar or close to that of dyed cellulosic fabrics bleached with hydrogen peroxide.

Summary of (Chapter 2)

The present work deals with the photo degradation of Two Cotton fabrics were done as follows : G70: Extra –Long staple Egyption cotton & G89: Long staple Egyption cotton fabrics caused by monthly direct exposure to the environmental conditions at an urban industrial site in Egypt – Helwan and Alexandria citys for one year.

The produced deteriorations were assessed as per different methods: thus, chemical, physical and mechanical measurements were used to follow the produced degradation. Studying the environmental conditions prevailing at Helwan city, the obtained data proved that this location is highly polluted as a result of the presence of different industries, e. h. : Cement (three factories), Iron and Steel, Coke, Textiles and cars, Metrological, Chemicals, Pipes, and many others While Alexandria city was the best.

The environment at Helwan is highly contaminated with a large amount of cement dust and other pollutants and that their effects are very pronounced during summer time and especially in august. Besides, acid mists was also detected there than Alexandria city.When the climatic conditions data applied from the nearest meteorological station to Helwan city were analyzed, we obtained a cyclic variation for the monthly amount of each of the following :

the incident total sun hours, ultraviolet radiation values of the surroundings, having a maximum in (June , July , August) and a minimum in (December, January) , the incident total the temperature of the surroundings, having a maximum in (May, June , July) and a minimum in ((December, January, February) .

While the Alexandrya city the climatic conditions data applied from the nearest meteorological station to Alexandrya city were analyzed, we obtained a cyclic variation for the monthly amount of each of the following parameters :

the incident total sun hours, ultraviolet radiation values of the surroundings, having a maximum in (June , July , August) and a minimum in (December, January) , that is hight than Helwan city. The incident total the temperature of the surroundings, having a maximum in (May, June , July) and a minimum in ((December, January, February) , that is less than Helwan city. A similar cyclic relation was found when plotting the deterioration in the mechanical properties expressed as tensile strength and/or elongation% with the months of the year emphasizing that the summer time is probably the most effective period in producing photo degradation to the textile fabrics in question and that the maximum deterioration was observed during August for both examined parameters. On the other hand, a linear relation was obtained when plotting the monthly amount of the incident solar energy against the produced losses in tensile strength or elongation %. Better correlation was obtained when the level of UV(290-315) radiation was applied which calls to the contribution of the UV radiation in textile photo degradation. Nevertheless, the observed damage after the continues exposure for one year was not inconsistent with the absorbed amount of energy in comparison with that produced after the month of august alone

which clarified the pronounced role pollution in producing degrading to the exposed textiles during. The whiteness index for the exposed clothes decreased contiuously with exposure during the whole year.While the yellowness index increased.Also, the brightness decreased. Also, it is observed that the degradation of the samples exposed in Helwan is > that of the samples exposed in Alexandria.This degradation was because of the high pollution in Helwan city. It is observed from the previous tables that the degradation of the exposed samples in Alexandria city is less than Helwan city and this could be because pollution in Alexandria city is less than that in Helwan city.

There is much degradation in tensile strength and elongation of the samples that were exposed for successive eight months more than that for the samples which were exposed for four months only. Also, it was found that there is no more degradation in samples exposed for more than eight months. The samples exposed in Alexandria had better tensile strength and elongation than that of Helwan in spite of the increase in ultraviolet and total sun hours .This emphasize the effect of pollution in Helwan in degradation of samples. Summary

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