

An investigation of the concentration and performance of locally produced cotton desizing enzyme

Josphat Igadwa Mwasiagi^{1,2*}, Winnie Tonui¹, Jacob Ngadia¹, John Lusweti Kituyi³, Lodrick Wangatia²

¹School of Engineering, Moi University, Eldoret, Kenya

²Ethiopian Institute of Textile and Fashion Technology, Bahir Dar University, Bahir Dar, Ethiopia

³School of Science, University of Eldoret, Eldoret, Kenya

(* Author for correspondence: igadwa@gmail.com)

Abstract: The textile industry has had its share of problems in the last decade. One of the remedial actions proposed by the Government is to improve the competitiveness of the textile sector by reducing the cost of doing business. Given that the Kenyan factories have to pay higher rates than their competition, for electricity, transport and labor, any effort taken to reduce the cost of running a textile process will be a boast to the industry. Furthermore vision 2030, envisages an increase in the manufacturing sector in Kenya. Therefore, the local production of cotton desizing enzyme will no doubt be a contribution to the industrialization process. It was with the aforementioned reasons in mind that a study of the performance of a locally produced enzyme during desizing was undertaken. The challenges reported during the use of the locally produced enzyme included the inability to determine the concentration of the enzyme. This paper reports the use of spectrophotometer to study the concentration and performance of the locally produced desizing enzyme. The results obtained in this research work showed that the locally produced enzyme could remove 85% of the starch in a plain weave fabric. The commercial enzyme could remove 98.3% of the starch.

Keywords: cotton, desizing, spectrophotometer, enzyme, potato waste, local production

1. INTRODUCTION

The sizing process is one of the important processes especially for factories dealing with woven cotton fabrics. As shown in Fig. 1, the weaving preparatory process begins with combination of between 300 to 800 yarns to form a layer of yarns. This is called the warpers beam. Several warpers beams are combined together in the subsequent process which is called sizing. During sizing the yarns are coated with synthetic or starch-based material to impart some strength to the yarns so that they can withstand the

vigorous tensile forces involved in weaving. Sizing also reduces yarn hairiness which could adversely affect the efficiency of the subsequent processes. The sizing material could range from 8 to 14% (by weight) of the yarn and its efficiency is affected by the size and type of the starch used (Xu et al., 2011; Hussein, 2007). Some oil may also be added to the sizing ingredients to reduce yarn to yarn abrasion. While the sizing process is important, after weaving the size material is of no further use. Sizing material imparts poor water absorption to the yarn. This is not good, and will be detrimental to the subsequent pre-

coloration, coloration and post coloration processes needed to make the fabric acceptable for human and industrial use. The size material can be removed from the fabric in a process called desizing, which involves breaking down the insoluble complex sugars found in the size material into simple soluble sugars. One of the main disadvantage of the desizing process is that it can contribute up to 50% of the total pollution load of a mills waste water (Achwal et al., 1990). Therefore, the optimization of the desizing process will go a long way in cutting down the cost of cotton processing.

Some of the desizing methods used in the textile industry include oxidative, acid and enzymatic desizing. Enzymes are biodegradable and are therefore be an attractive option for most textile factories. Furthermore the enzymatic desizing process produces less adverse effects to the quality of the fabrics (Hussein, 2007). The enzymatic desizing process may be divided into three processes; (i) impregnation (ii) incubation and (iii) after-wash. During the impregnation process the enzyme solution is

absorbed by the fabric, at optimum temperature and pH to cause the gelatinization of the size (starch) (Qi et al., 2011; Li et al., 2012). Once the enzyme has been absorbed by the fabric the enzyme breaks-down the size. The control of the incubation period will affect the efficiency of the desizing process. The final process involves the washing away of the broken down complex sugars and hence the removal of the size. This should be down using a detergent and optimum washing temperature. Recent research into the improvement of desizing process, include the use of ultrasonic and plasma treatment methods (Qi et al., 2011, Sahinbaskan, 2011; Mori et al., 1999). The traditional desizing process is however still being widely applied in the textile industry because the new methods are expensive and tend to reduce fabric strength.

Another line of research in the enzymatic desizing process has been undertaken by Anis et al (Bedi, 2003) who used other types of enzymes commonly used in the food industry.

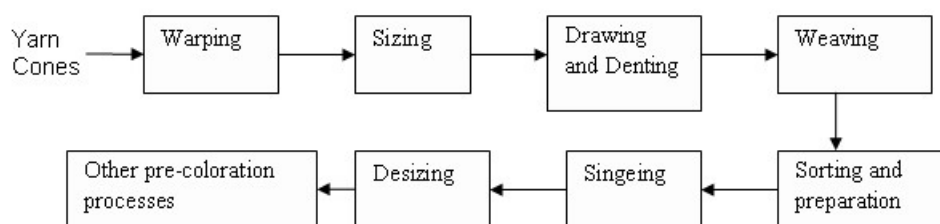


Figure 1 The Sequence of weaving preparatory, weaving and pre-coloration processes

The results of the aforementioned research are encouraging and produced well desized fabric in a shorter period of time. The study has however been limited at the laboratory level. It is hoped that industrial scale

research will be undertaken to popularize the new types of enzymes. While the desizing process is mandatory for cotton woven fabric, the desizing chemicals used in the Kenyan textile factories have to be imported

from Europe or Asia. This strains the scarce foreign exchange apart from holding up the factory finance due to the fact that the factory has to order higher stocks of desizing chemicals. The textile industry has had its share of problems in the last decade. One of the remedial actions proposed by Kenya Associations of Manufacturers (KAM) is to improve the competitiveness of the textile sector by reducing the cost of doing business (Ikiara & Ndirangu, 2003). Given that the Kenyan factories have to pay higher rates than their competition, for electricity, transport and labor (Government of Kenya, 2007), any effort taken to reduce the cost of running a textile process will be a boast to the industry. Furthermore vision 2030 (Mwasiagi et al., 2011) envisages an increase in the manufacturing industry in Kenya. The manufacturing of cotton desizing enzyme locally will no doubt be a contribution of the industrialization process. It was with the aforementioned reasons in mind that a study of the performance of a locally produced enzyme (Teli et al., 2008) was undertaken. The challenges reported during the use of the locally produced enzyme included the inability to determine the concentration of the enzyme. This paper reports the use of spectrophotometer to study the concentration of the locally produced desizing enzyme. The optimization of the performance of the locally produced enzyme was also undertaken.

2. EXPERIMENTAL

The desizing enzyme was harvested from a bacteria obtained from the soil, by using potato waste as a bait. The potato waste was

collected from the Eldoret municipal market. The harvested bacteria amylase was cultured, concentrated and used for the experiments. The experiments carried out included; determination of concentration of extracted enzymes, effect of temperature and pH on enzyme activity during desizing of a plain weave fabric of Nm 8 warps and Nm 14 weft counts, with a size pick-up of 12%.

To determine the concentration of extracted concentration of commercial enzymes, was drawn. By using different concentrations and corresponding absorbance as measured by the A range of 0.03 to 13 g/l of the commercial enzyme was prepared and used to draw a standard curve. The standard curve was used to study the concentration of the locally made enzyme.

The absorbance of the enzymes was determined using the iodine test method. As reported by Anis et al (Bedi, 2003), when starch is mixed with an enzyme solution, the enzyme will break down the starch, up to a point where all the enzyme will be consumed. A measure of the amount of residual can be used to study the activity of the enzyme. If iodine solution is added to the mixture of enzyme and starch, the iodine will react with the residual starch producing a blue color. The intensity of the blue color will depend on the amount of the residual starch which is inversely proportional to the amount of enzyme present before the start of the experiment. The intensity of the blue color was measured using the spectrophotometer.

To study the efficiency of the enzymes, the desizing efficiency was monitored during the desizing of a plain weave fabric

using the following parameters; (i) Bath Temp: 60°C, (ii) Enzyme Concentration: (0.015-4.6 (varied), (ii) Wetting agent : 0.75 g/l (iii) Acetic acid to adjust pH : 7, (iv) Washing: done using detergent. The efficiency of the desizing process was calculated using the weight loss method suggested by Teli and Chakrabart .

3. RESULTS AND DISCUSSIONS

3.1. Standard Curve

The standard curve was drawn as explained earlier. The absorbance of the different concentrations of the commercial enzyme were recorded, and the results are given in Fig. 2.

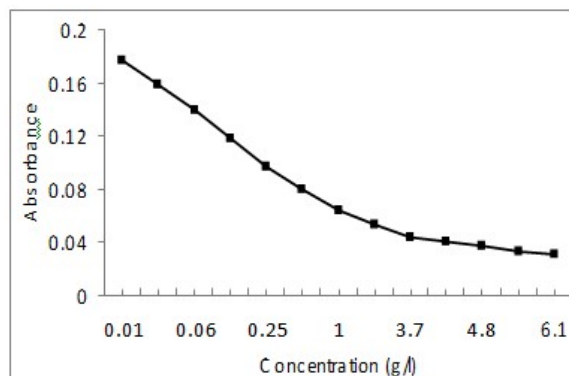


Figure 2 The standard curve obtained by using the commercial enzyme

The curve slopes downwards showing that absorbance is inversely proportional to concentration. As explained earlier when a solution which is highly concentrated with enzymes is reacted with starch solution, there would be a higher percentage of starch degraded than in a solution containing less enzymes. The amount of starch not degraded is free to react with iodine to form the blue color, whose intensity can be

measured by the spectrophotometer. Higher absorbance shows that a larger amount of starch was not degraded meaning that there was lower concentration of enzymes. The standard curve was used to study the concentration and performance of the locally produced enzyme.

Different samples of the locally produced enzyme were prepared. The concentration of the locally produced enzyme was determined using the standard curve. The range of the concentration of the locally produced enzyme was from 0.015 to 4.6 g/l. While the study of the factors which influenced the concentration of the enzyme was beyond the scope of this study, it was however noted that the number of days the bait stayed in the soil and the general conditions of the soil (moisture, temperature etc) affected the amount of bacteria harvested.

3.2. The Effects of pH on Enzyme Activity

By preparing a solution of enzyme from the locally produced enzyme a study of the effect of pH on the performance of the enzyme was undertaken and the activity of the enzyme measured using the iodine method. As shown in Fig. 3 the absorbance of the enzyme solution is sensitive to pH. At neutral pH (7) the absorption of the enzyme was at its lowest. This was an indication of maximum activity of the enzyme. Acid and alkali pH do not promote the activity of the locally produced enzyme, and should therefore be avoided. For optimum performance the recommended

working pH for the enzyme as indicated by this research work was 7.

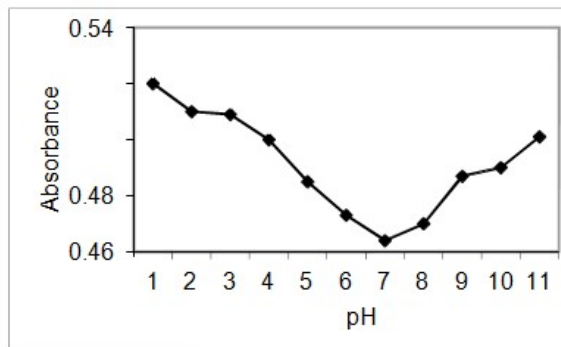


Figure 3 Effect of pH on Enzyme Activity

3.3. The Effects of Temperature on Enzyme Activity

A study of the effect of temperature on the enzyme activity was performed by subjecting the enzyme to different temperatures and by using the iodine test, the activity of the enzyme was monitored. The results are given in Fig. 4. The effect of temperature on the enzyme activity showed similar trend as that of the pH, with an optimum temperature of 70°C.

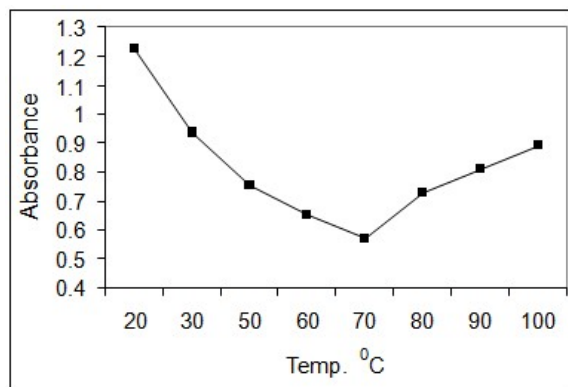


Figure 4 Effect of Temperature on Enzyme activity

At lower temperatures the enzymes were inactive therefore less starch was degraded in the solution. Increase in temperature beyond optimum temperature

lead to the denaturing of enzymes leading to less degradation of starch.

3.4. The Effect of Storage on Enzyme Activity

One of the important properties for an industrial product is its shelf life. The locally made enzyme is in a liquid media. A study of the effect of storage time for the locally produced enzyme was performed by storing the enzyme solution for a given number of days and then studying the activity of the enzyme using the iodine method.

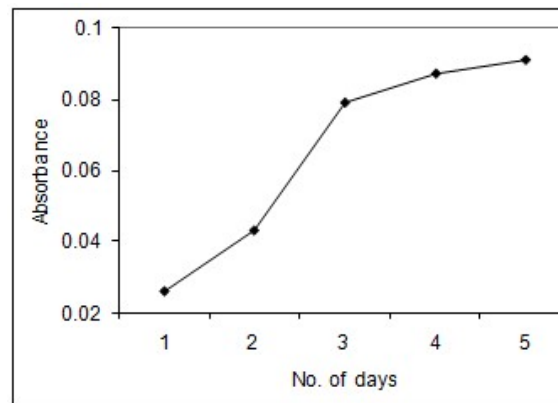


Figure 5 Effect of Storage on Enzyme activity

As shown in Fig. 5 the efficiency of the enzyme decreased with time. The enzyme gets deactivated when stored at room temperatures for longer periods. Enzymes stored for a longer periods are less active in degrading starch. The activity of enzymes was higher when stored for one day and lower when stored for five days as shown in Fig. 5. In fact after 72 hours (3 days) the concentration of the enzyme is drastically reduced. From performance point of view, the enzyme should be used as soon as possible.

3.5. The Performance of the Locally Produced Enzyme during Desizing

Having established optimum performance parameters for the locally produced enzyme, an enzyme solution was prepared and used for desizing. The conditions were; (i) pH: 7; (ii) Temperature: 70°C, storage: freshly prepared. Desizing of a plain weave fabric with a size of 12% was done and the results are given in Fig. 6. From the results obtained, the rate of desizing increased with the increase of the concentration of the enzyme. This is expected. Higher concentration avails more enzymes hence more desizing occurs.

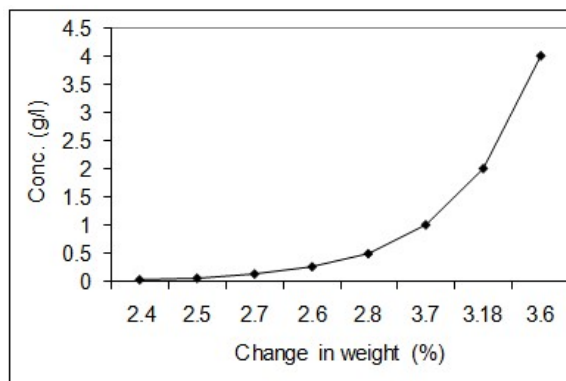


Figure 6 Effect of Enzyme Concentration on Desizing

A comparative study of the performance of the commercial and locally produced enzyme was done and it indicated that the maximum starch removed from a fabric with size of 12% by the locally produced enzyme was 10.2%, while the commercial enzyme removed 11.8%. The performance can therefore be adjudged to be 85% and 98.3% for the local and commercial enzyme respectively.

4. CONCLUSIONS

A locally produced enzyme, harvested from the soil by using potato waste was produced and its concentration and performance investigated using a spectrophotometer. The results obtained from the experiments carried out in this research work, indicated that; (i) The concentration of the extracted enzyme varied from 0.015 g/l to 4.6 g/l, (ii) The optimum performance conditions for the locally produced enzyme during the desizing of cotton fabric was; pH of 7 and temperature of 60°C (iii) The locally produced enzyme was able to remove 85% of the size material. The results are acceptable although lower than that of the commercial enzyme which stood at 98.3%. There is need for further research so as to improve the performance of the locally produced enzyme. Research should also be done to improve its shelf life.

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