Enzyme Dissolution Technique for Studying the Fine Structure of Jute Fiber at Different Stages of Growth

Cuene dissolution technique has been widely used for the evaluation of chemically modified cotton fibers. However, the application of cuene may cause some morphological changes because of heavy swelling leading to some ambiguous results. Betrabet[1] showed that cellulase enzyme might be used as an alternative to cuene as a cellulose-dissolving agent without causing any change in the morphology. Using this technique he studied successfully various chemically modified cotton fibers. We have also used this cellulase enzyme dissolution technique in case of jute fibers, though in a slightly different context.

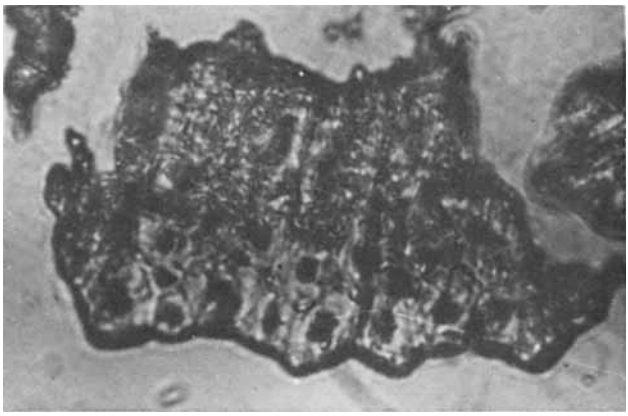

Fig. 1. Mature jute fiber cross section. Thickness 10 μm, magnification 630×.

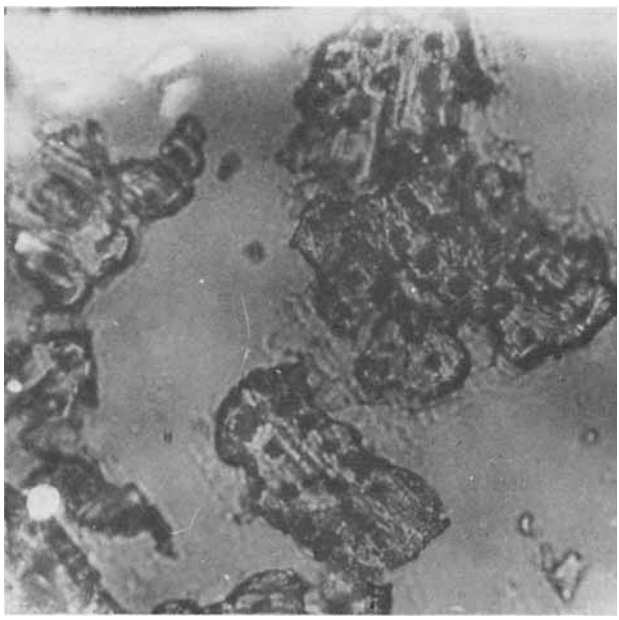

Fig. 2. Mature jute fiber cross sections treated with cellulase enzyme solution (strength *Y*) for 30 min. Thickness 10 μm, magnification 610×.

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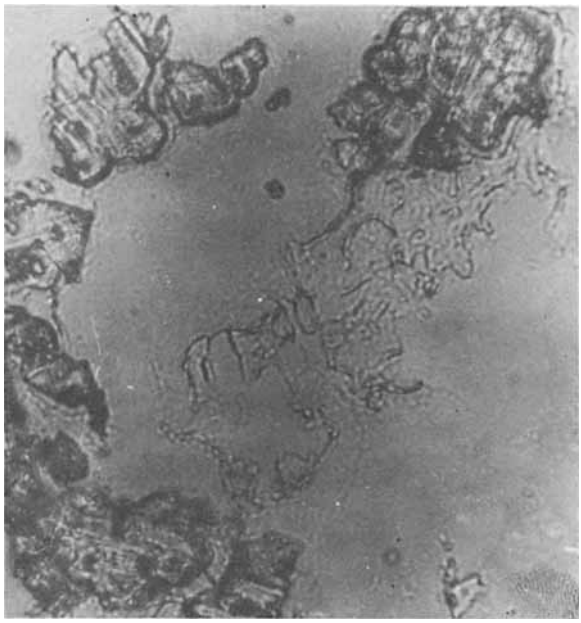

Fig. 3. Mature jute fiber cross sections treated with cellulase enzyme solution (Y) for 1 hr. Thickness 10 μm, magnification 610×.

It was shown that when the cross sections of cotton fibers are treated with enzyme solution, the enzyme dissolves the cellulose. If, however, the cotton is crosslinked, the dissolution of cellulose will be less for the same strength of enzyme solution and duration of treatment.[1] In case of jute fiber, it was reported earlier[2] that at the very early stage of growth (say 11 days after germination) lignin remains as a separate phase, and as the fiber matures lignin infiltrates into the cellulose network, forming some sort of strong bonds with the cellulose chains. It was thought that some confirmation of the above concept may be obtained by applying the cellulose dissolution technique in this case.

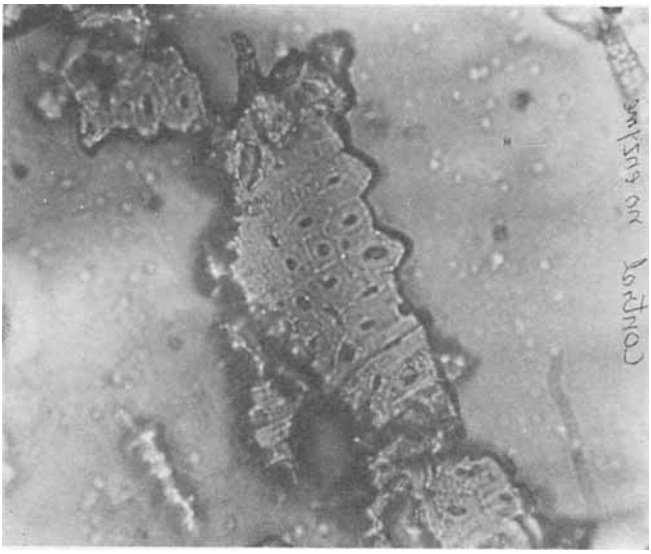

Fig. 4. Mature jute fiber cross sections. Thickness 10 μm, magnification 540×.

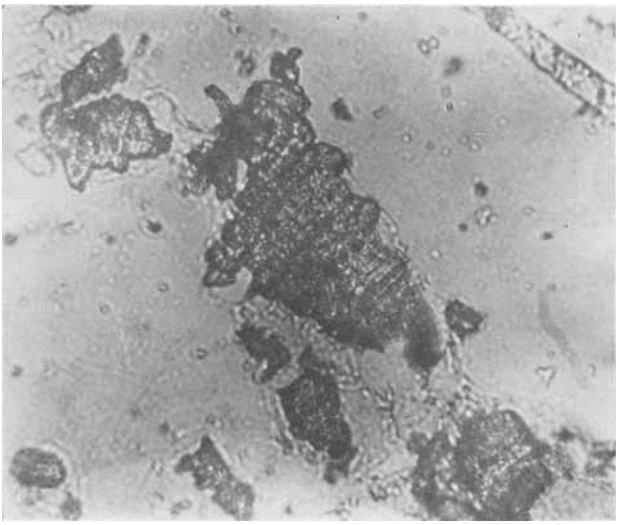

Fig. 5. Mature jute fiber cross sections treated with diluted cellulase enzyme solution (Y/2) 10 min. Thickness 10 μm, magnification 540×.

Jute fiber cross sections (10 μm thick) were therefore immersed in the cellulase enzyme solution, adjusted to pH 4.8 using 0.05*M* sodium citrate as buffer, and incubated in an incubator at 50°C for specified periods. At the end of incubation, the cross sections were washed with distilled water to make them free from enzyme solution. Photographs were taken using a projection microscope using 500× magnification.

A typical cross section of mature jute fiber is shown in Figure 1. The enzyme action at the end of 30 min causes some dissolution of the fiber cross sections, as shown in Figure 2. Figure 3 shows the same mature fiber cross sections after treatment for 30 min further. When the 11-day-old fiber was treated for the same period with the same concentration of the enzyme solution as was used for the mature fiber, the dissolution of cellulose in the 11-day-old fiber was so great that to photograph it was meaningless. The original enzyme solution was then diluted (1:2) with the buffer solution. Figures 4 and 5 show the effect of this solution with mature fiber. The strength of this enzyme solution was also found to be too high for the 11-day-old fiber. Therefore, the original solution was

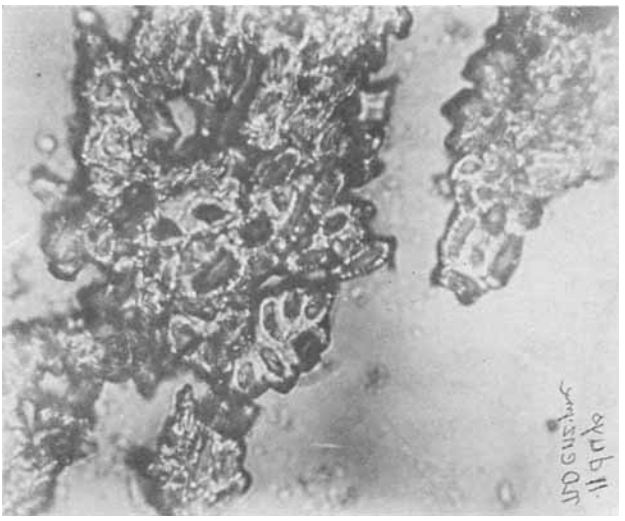

Fig. 6. Eleven-day-old fiber cross sections. Thickness 10 μm, magnification 590×.

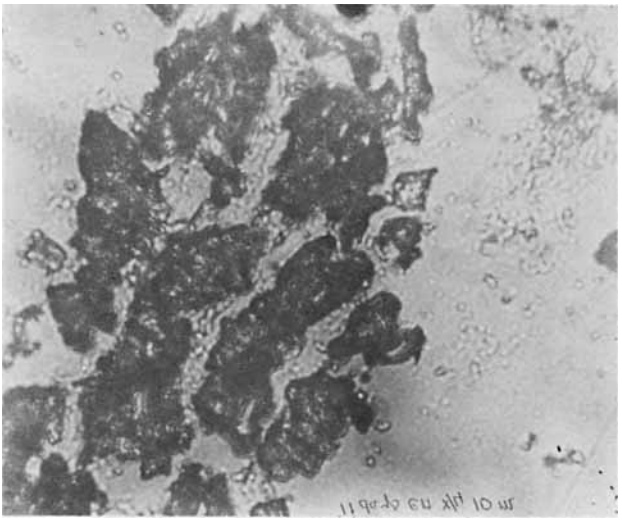

Fig. 7. Eleven-day-old fiber cross sections treated with diluted cellulase enzyme solution ($Y/4$). Thickness 10 μm, magnification 590×.

further diluted (1:4). Figures 6 and 7 show the effect for the 11-day-old fiber. From these observations we see that the mature fiber cross sections suffer much less degradation than the cross sections of the 11-day-old fiber, on treatment with enzymes, even though a stronger enzyme solution was used for the mature fiber.

The results thus seem to confirm our earlier observations about the development of structures of jute fiber with growth.

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References

1. S. M. Betrabet and K. M. Paralikar, J. *Appl. Polym. Sci.*, **20,** 1651 (1976).
2. U. Mukhopadhyay and A. C. Mukherjee, *Text. Res. J.*, **47,** 224 (1977).

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