EFFECTIVE AND ECONOMICAL ENZYMATIC UPGRADEATION OF JUTE

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SUMMARY: An effective and economical protocol for the production of cell-
ulase and its application in the upgrading of lower grade (W5) jute
envisages steeping of W5 jute at 28 ± 2°C for 72 hr in acetate buffer
(0.01M, pH 4.5) fortified with cellulase, washing with tap water and drying
under sunlight. Compared with untreated and buffer-treated jute, the
-treated jute was remarkably softened, lustrous, with reduced stiffness and
crading resistance and improved tenacity, was less susceptible to fungal
deterioration during storage and showed good market acceptability.

INTRODUCTION

The jute industry is based on the use of jute fibre (lignocellulose) as a
raw material occurring in the phloem region of the bark of Corchorus
capsularis and Corchorus olitorius, and recovered by microbiological
retting. The industry often faces a shortage of raw material and then has
to depend upon a larger proportion of lower-grade jute fibres to maintain
normal production. Such substitution is only possible if lower-grade
fibres are softened and cleansed by a proper upgrading treatment. For this
purpose, a process based on the use of enzymes derived from Aspergillus
terreus (IJIRA 6.2), developed by Gnoose and Dutta (1980, 1983) is used by
several jute mills around Calcutta. However, the efficiency and economy of
this process is marred since A.terreus produces both cellulase and a
-cellulase inhibitor (Sinha et al, 1981). We sought an alternative source of
a cellulase preparation which could be directly used for upgrading lower
grades of jute, and describe here an effective and economical protocol.

MATERIALS AND METHODS

Lower grade jute: W5 (bottom) grade jute available abundantly was selected
for upgrading.

Cellulase preparation: UV-exposed Trichoderma viride SNC strain
(Ramamurthy et al, 1967) for higher production of cellulase was propagated
in microcrystallin cellulose-rich medium at 28°C, pH 4.0 for 220 hr. It
afforded 550 ± 50 units CMCase and 20 ± 2 units FPase activities (Mandels et
al, 1974) after basket centrifugation (1600 RPM, 28°C). Ammonium sulfate
at 50% saturation precipitated these activities with 85% recovery. The dry
enzyme preparation contained 10,000 units/g CMCase and 700 units/g FPase
activity, with 85% stability in dry storage at ambient temperature over a
period of one year. Cost estimates of raw material, utilities, labour and
capital suggested that 10 million units CMCase would cost about 15 $ US.

Experimental: Upgrading trials were carried out in triplicate under
optimized conditions fixed earlier by trial and error (Ramamurthy et al,
1967). A typical study involved the steeping at 28 ± 2°C for 72 hr of 250
gram W5 grade jute in 250 ml acetate buffer (0.01 M, pH 4.5) with and without
cellulase. The untreated sample served as a master control, sample treated
with buffer alone served as a control and samples treated with buffer
fortified with varying amounts of cellulase (CMCase) as experimentals. At
the end of steeping, fibres in control and experimentals were repeatedly
washed with tap water, dried under sunlight and examined for their
appearance, colour, fineness, tenacity, carding resistance and stiffness.

Analytical methods to test textile properties: Untreated, acetate buffer
treated and variously CMCase treated jute fibres were examined for the
following textile properties.

(a) Finess : determined by Indian Standard air flow method (1976) and
expressed as denier.
(b) Tenacity of bundle : determined by Indian standard method (1975).
(c) Carding resistance : was determined using IJIRA fibre parallelisation
tester consisting of (a) steel pin holder, (b) specimen holding clamp
and (c) mechanism for drawing the pin along the length of specimen jute.
A 20 cm long jute bundle weighing about 50 gm, cut from the middle
portion of the reed, is placed on the platform of the tester and fixed
at one end by a grip provided on the platform. The comb (fitted with
three pins) is placed on the specimen and penetrated into it so that the
pins in the comb remain completely embedded in the test specimen
without coming in contact with the surface of the platform underneath.
The comb attachment with four wheels is able to move freely over a pair
of parallel rails and is drawn by hand through the specimen at the speed
of 5 mm per second. The force required to draw the comb through a fixed
distance (one and two inch separately) is measured on the calibrated
dial of the force indicator. Two sets of readings having 10 tests for
each one-inch and two-inch drag are taken on each CMCase treated and
control samples.
(d) Stiffness : was determined in two ways : (i) the specimen of 20 cm
length (weight 1.3-1.4 gm) was overhung from a horizontal platform with
a constant load of 0.28 gm and the bending angle was recorded with a
suitable device. Ten tests were performed on each sample. The higher
the bending, lower was the stiffness; (ii) the distance (cm) between
two hanging legs of fibre bundle of 20 cm length (weighing 0.55-0.56 gm)
was measured when hung over a glass rod 3.0 mm diameter with a constant
weight of 1 gm attached to each leg of the bundle. The higher the
distance (cm), the higher was the stiffness.

RESULTS AND DISCUSSION

Appearance and colour : The appearance and feel tests revealed a remarkable
improvement in terms of softening and lustre in cellulase-treated jute
fibre over the controls. Cellulase treatment led to a slight browning of
the fibre, well within the acceptable limit.

Finessness and tenacity : various textile properties of cellulase treated
jute fibre (see above) were examined in detail (Table 1). Finess showed a
positive improvement upon cellulase treatment. The highest degree of
finess was obtained after treatment 3. That the improved finess is
accompanied by no loss of strength is the most notable desired feature. The
increased finess is believed to be effected by the minor dissolution
(polishing action) of surface components of fibre, which is reflected by
increased tenacity of bundles of enzyme treated jute fibre, over the
controls. The highest strength is exhibited in enzyme treatment 1 which is
followed by treatment 2 and 3. However, the mechanism of increased finess
and concurrent enhancement of strength and the inter-relation between these
vital textile parameters are not understood at present.