# SAWTRI TECHNICAL REPORT

## No. 490

# Chemical Modification and Processing of *Phormium tenax* Fibres

## Part III: The Effect of Certain Softening Conditions on Fibre, Yarn and Fabric Properties

by

**E. Weideman and G.A. Robinson**

SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH
INSTITUTE OF THE CSIR

P.O. BOX 1124
PORT ELIZABETH
REPUBLIC OF SOUTH AFRICA

ISBN 0 7988 1969 3

# CHEMICAL MODIFICATION AND PROCESSING OF *Phormium tenax* FIBRES
# PART III: THE EFFECT OF CERTAIN SOFTENING CONDITIONS ON FIBRE, YARN AND FABRIC PROPERTIES

*by E. WEIDEMAN and G.A. ROBINSON*

## ABSTRACT

*Phormium fibre was softened under different conditions and then spun with the aid of two different core yarns on the DREF system. The yarn was woven as weft in a curtaining fabric. The fabrics were finished in three different ways and the effects of processing on fibre, yarn and fabric properties were determined.*

*The various softening treatments generally did not materially affect the fibre fineness, fibre bundle tenacity or yarn properties. The type of core, however, significantly affected the yarn and fabric properties. The polyester/cotton core yarns gave fabrics with lower mass and these fabrics were also thinner. In spite of this they had significantly higher bursting strengths and better abrasion resistance. They were also superior from the point of view of drape and washing shrinkage.*

*The fabrics had a natural rustic appearance, were attractive, and had satisfactory draping qualities.*

## INTRODUCTION

Results of initial laboratory work on the chemical softening of phormium were reported previously[1]. Some trials were also carried out to demonstrate that such softened fibre can be woven successfully as weft into curtaining fabrics. Optimum conditions for the softening of Phormium in a batchwise laboratory treatment were established by determining the tenacity and yield of the softened fibres[2]. It was necessary, however, to extend the above study to cover larger scale treatments and to investigate the effect of variables such as the temperature of the rinsing water after chemical treatment and the number of times the fibre passed through the squeeze rollers after lubrication. These factors were considered important in producing fine, clean fibres. At the same time it was decided to evaluate the effect of using a detergent during the chemical softening process on the properties of the softened fibres, and also the effect of some different core yarns as well as some different fabric finishing treatments on the properties of the fabrics produced.

## EXPERIMENTAL

Eight experiments were planned according to a $2^3$ factorial design involving the following variables:

1. Chemical softening with or without a wetting agent.
2. Hot or cold rinsing after chemical softening.
3. One or three passages through the squeeze heads of an experimental scouring machine.

The above variables produced eight lots of fibre.

### Chemical and Mechanical Softening

A 200 kg lot of Corona decorticated phormium fibre in loose carded form was divided into two equal parts. One part was softened by treating with 0,4% (m/v) sodium hydroxide at a 40 : 1 liquor-to-goods ratio as described in an earlier report[1]. The remaining part was softened in the same way except that it was treated with a liquor containing 4 g/$\ell$ of ®Dypenol 731-NF detergent (a mercerising assistant) (see Table II). After the chemical treatment, a further subdivision allowed for one sub-lot of both treatments to be rinsed at room temperature and the other in hot water (65° C). After rinsing, the four sub-lots were squeezed and then immersed in a bath containing 5% ®Bevaloid 4027 (a fibre lubricant), and finally squeezed ready for opening. Half of each of these sub-lots was further lubricated and squeezed twice (3 times in all) resulting in eight lots of fibre for processing. These lots were willeyed wet and finally dried at 80° C in a Fleissner suction drum dryer.

### Carding

Each lot was hand-blended with 10% polypropylene staple fibre (11 dtex, 150 mm) to improve cohesion and assist in subsequent processing. This blend was carded on a Turner Atherton card before delivering in sliver form.

### Gilling and Drawing

The carded slivers were gilled three times on a Schlumberger GNP gillbox as described in a previous publication[1] to produce drawn slivers of 10 ktex.

**Spinning**

Each of the eight lots of drawn slivers was spun into R200 tex yarn on a Dref MK II spinning machine using two different cores:

(a) 40 tex spun polypropylene yarn and

(b) two 40 tex spun polyester/cotton (50/50) yarns.

An initial attempt to spin phormium without the use of a core yarn was unsuccessful. One 40 tex polyester/cotton yarn as core was also found to be unsatisfactory. All the yarns were spun from slivers at a delivery speed of 72,0 m/min . The speed of the perforated drum was 1500 revs/min . All the yarns were steam set and were used as weft only.

**Weaving:**

A warp of 1090 ends of R126 tex S 340/3 Z 590 polyester/cotton (50/50) yarn, dented singly over a reed width of 173 cm, was woven on a 200 cm Dornier GTN 6/SD rapier loom into a 2/2 twill using the various Drefspun phormium yarns as weft (10,3 picks/cm). Sixteen fabrics were produced.

**Finishing**

Preliminary trials were performed and it was decided that three alternative finishing routes should be studied, namely (1) scouring, (2) crabbing and (3) scouring and crabbing, each to be followed by rinsing and drying in the stenter.

**Scouring**

The sixteen fabrics were all scoured in a winch using 5% (omf) soda ash and 0,5 g/$\ell$ ®Nonidet P40 at 98° C for 60 min, rinsed at 40° C and then at 25° C and finally dried on the stenter at 100° C.

**Crabbing**

Crabbing was carried out at 80° C for 20 min. The changes in fabric width during finishing are shown in Table II.

**Testing:**

The various fabrics were tested for mass, thickness, bursting strength, abrasion resistance, stiffness, drape and shrinkage during washing (AATCC IIB) and the results are shown in Table III. A specimen of the Phormium curtaining is shown in the Appendix.

## RESULTS AND DISCUSSION

### Softening of the fibre

The properties of the softened phormium fibres are given in Table I and show that the different softening conditions had little effect on the fibre fineness or bundle tenacity, with, if anything, the fibre softened without detergent, rinsed cold and squeezed once only, the best. There was little or no effect on fibre length.

**TABLE I**

**PROPERTIES OF SOFTENED PHORMIUM FIBRE**

| SOFTENED FIBRE | | | Fibre Linear Density (tex) | Fibre Bundle Tenacity (cN/tex) | Fibre Length (mm) |
|---|---|---|---|---|---|
| Detergent present | Rinsing Hot or Cold | No. of Oilings and Squeezes | | | |
| No | Cold | 1 | 6,8 | 20,3 | 82 |
| | | 3 | 7,0 | 18,6 | 80 |
| | Hot | 1 | 7,4 | 20,2 | 70 |
| | | 3 | 7,2 | 17,2 | 87 |
| Yes | Cold | 1 | 8,8 | 18,2 | 79 |
| | | 3 | 9,8 | 19,4 | 70 |
| | Hot | 1 | 8,5 | 20,1 | 81 |
| | | 3 | 8,2 | 17,6 | 84 |

**Yarn Properties**

Some physical properties of the yarns are shown in Table II, from which it is apparent that the various softening conditions did not have a significant effect on the yarn properties. The type of core yarn used, however, had a significant effect on the breaking strength, tenacity, extension and CV's of tenacity and extension.

**Weaving**

All the yarns performed well during weaving.

**Finishing**

From Table III it can be seen that for the fabrics which had either been scoured only or scoured and crabbed, those incorporating a spun polypropylene core finished at 135 cm width whereas those incorporating a polyester/cotton core finished wider, at approximately 145 to 150 cm. When scouring was eliminated, the fabrics finished much wider (145 to 150 cm) showing that scouring caused excessive shrinkage.

**Fabric Properties**

An analysis of variance showed that generally the softening conditions had no significant effect on the fabric physical properties and therefore the results for all the softening conditions were pooled and the results given in Table IV. The fabrics which had been crabbed had the lowest mass because of less shrinkage. During crabbing the fabrics were prevented from shrinking and therefore these fabrics showed higher shrinkage values after washing than the scoured fabrics where shrinkage already occurred during the scouring process. They were also the thinnest. Martindale abrasion results indicated that scouring improved the abrasion resistance slightly. Widthwise shrinkage was affected by the finishing process.

The polyester/cotton core yarns gave fabrics with lower mass and these fabrics were also thinner. In spite of this they had significantly higher bursting strengths and higher abrasion resistance. They were also superior from the point of view of drape and washing shrinkage.

The length shrinkages of all the fabrics during washing was considered acceptable for this type of fabric.

The curtaining had an attractive natural rustic appearance with good draping qualities.

## TABLE II

## THE EFFECT OF SOFTENING CONDITIONS AND TYPE OF CORE ON THE YARN PHYSICAL PROPERTIES

| Core | No. of Squeezes | Detergent present | Rinsing Conditions | Linear Density (tex) | Breaking Strength | | Tenacity (cN/tex) | Extension at Break (%) | CV (%) | Irregularity (CV %) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Mean (cN) | CV (%) | | | | |
| 40 tex staple polypropylene yarn | 3 | Yes | Hot | 206 | 1080 | 12,6 | 5,2 | 20,3 | 22,3 | 23,2 |
| | | | Cold | 207 | 1180 | 10,5 | 5,7 | 24,4 | 18,4 | 23,0 |
| | | No | Hot | 205 | 1230 | 14,4 | 6,0 | 18,7 | 25,8 | 24,3 |
| | | | Cold | 210 | 1100 | 14,2 | 5,2 | 19,6 | 25,5 | 23,8 |
| | 1 | Yes | Hot | 217 | 1110 | 12,5 | 5,1 | 22,1 | 24,8 | 22,3 |
| | | | Cold | 228 | 1170 | 10,9 | 5,1 | 21,7 | 23,4 | 22,2 |
| | | No | Hot | 207 | 1130 | 12,5 | 5,4 | 18,8 | 32,0 | 21,9 |
| | | | Cold | 211 | 1160 | 8,1 | 5,5 | 21,7 | 16,0 | 23,4 |
| Two 40 tex polyester/ cotton yarns | 3 | Yes | Hot | 198 | 1810 | 6,9 | 9,1 | 11,6 | 12,5 | 23,2 |
| | | | Cold | 205 | 1870 | 3,2 | 9,1 | 11,5 | 6,6 | 22,3 |
| | | No | Hot | 196 | 1680 | 4,7 | 8,6 | 10,9 | 13,6 | 22,3 |
| | | | Cold | 195 | 1680 | 8,7 | 8,6 | 11,2 | 12,2 | 21,6 |
| | 1 | Yes | Hot | 206 | 1840 | 6,0 | 8,9 | 10,1 | 8,1 | 23,1 |
| | | | Cold | 205 | 1720 | 8,5 | 8,4 | 12,2 | 6,2 | 22,7 |
| | | No | Hot | 204 | 1770 | 4,9 | 8,7 | 13,8 | 8,3 | 21,2 |
| | | | Cold | 223 | 1780 | 8,2 | 8,0 | 11,8 | 11,9 | 21,8 |

## TABLE III

## CHANGES IN FABRIC DIMENSIONS DURING FINISHING

| FINISHING PROCEDURES | FABRIC WIDTHS (cm) | | | | |
|---|---|---|---|---|---|
| | Core | Before Scouring | After Scouring | After Crabbing | After Drying |
| Scouring only | Polypropylene | 160/162 | 125 | — | 135 |
| | Polyester/Cotton | 160/162 | 140 | — | 145 |
| Crabbing only | Polypropylene | 160/162 | — | 145/150 | 150 |
| | Polyester/Cotton | 160/162 | — | 145/150 | 150 |
| Scouring and Crabbing | Polypropylene | 160/162 | 124 | 125 | 135 |
| | Polyester/Cotton | 160/162 | 140 | 145 | 150 |

## SUMMARY AND CONCLUSIONS

Phormium fibre was softened under different conditions, i.e. with and without detergent, followed by rinsing in either hot or cold water and then lubricated and squeezed once or three times, in an attempt to determine the effect of these conditions on the fibre, yarn and fabric properties.

The fibres softened under the above eight different conditions were blended with polypropylene fibre and spun to R200 tex yarns using the Dref spinning technique and two different core yarns viz. either a 40 tex polypropylene core yarn or two 40 tex polyester/cotton yarns were used as a core. The yarns were woven into a 2/2 twill construction using the phormium yarns as weft with a cotton/polyester warp. The fabrics were then finished by three different procedures, i.e. either scouring only, crabbing only or both scouring and crabbing.

It was found that the different softening conditions had little effect on the fineness or bundle tenacity of the fibres. If anything, softening without detergent followed by a cold rinsing and squeezing once only after lubrication generally produced the finest and strongest fibre. The different softening treatments did not affect the yarn properties significantly but the yarns containing two 40 tex cotton/polyester yarns as a core performed the best.

## TABLE IV

## THE PHYSICAL PROPERTIES OF THE FINISHED FABRICS

| Finishing Routine | Core Yarn | Fabric Mass ($g/m^2$) | Fabric Thickness (mm) | Bursting Strength ($kN/m^2$) | Martindale Abrasion (% Mass Loss after 10 000 cycles) | Cantilever Bending Length (cm) | Drape Coefficient (%) | Percentage Fabric Shrinkage (AATCC IIB 50° C 5 Washes | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Length | Width |
| Scour | 40 tex Polypropylene | 396 | 2,16 | 1713 | 3,4 | 2,4 | 68 | 3,7 | 11,6 |
| | Two 40 tex Polyester/ Cotton 50/50 | 345 | 1,90 | 2037 | 3,2 | 2,1 | 60 | 4,4 | 8.6 |
| Crab | 40 tex Polypropylene | 356 | 1,77 | 1853 | 4,8 | 2,3 | 68 | 4,8 | 18,5 |
| | Two 40 tex Polyester/ Cotton 50/50 | 336 | 1,69 | 2089 | 4,0 | 2,1 | 60 | 5,2 | 10,6 |
| Scour + Crab | 40 tex Polypropylene | 388 | 1,97 | 1627 | 4,0 | 2,4 | 68 | 4,4 | 11,6 |
| | Two 40 tex Polyester/ Cotton 50/50 | 340 | 1,67 | 1903 | 3,1 | 2,1 | 62 | 3,9 | 9,6 |

The various fibre pretreatments had no effect on the physical properties of the finished fabrics. The polyester/cotton core yarns gave fabrics with lower mass and these fabrics were also thinner. In spite of this they had significantly higher bursting strengths and better abrasion resistance. They were also superior from the point of view of drape and washing shrinkage.

Crabbing of the fabrics reduced fabric thickness and mass and also produced fabrics of correspondingly greater width than scouring but these fabrics shrank the most during washing. Scouring appeared to improve abrasion resistance but these fabrics were also the narrowest after finishing and consequently also the heaviest. Lengthwise shrinkage of the fabrics was not excessive.

Softened phormium curtaining has an attractive natural rustic appearance and drapes well. In-use evaluation is being carried out.

## THE USE OF PROPRIETARY NAMES

The fact that products with proprietary names have been mentioned in this report does not in any way imply that SAWTRI recommends them or that there are not substitutes which may be of equal value or even better.

## ACKNOWLEDGEMENTS

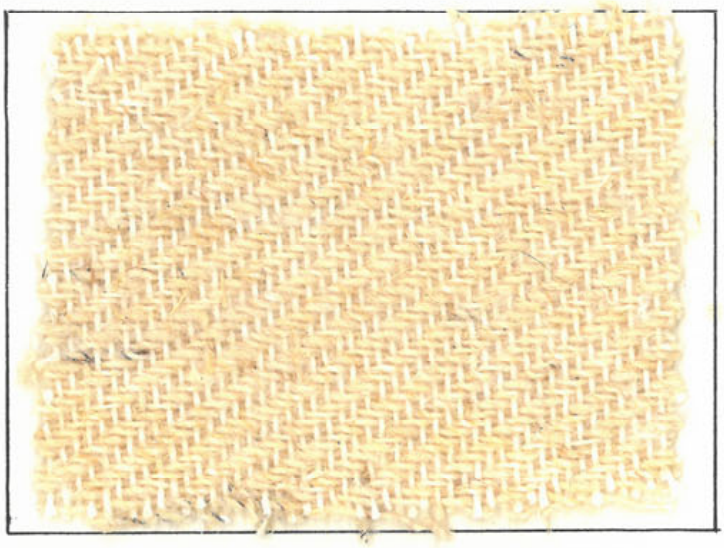
The authors wish to acknowledge the technical assistance of several staff members at SAWTRI who were involved in this project. Permission by the Department of Industries to publish this report is gratefully acknowledged.

## REFERENCES

1. Robinson, G.A., Weideman, E. and Spencer, J.D., *SAWTRI Bulletin,* **13**, 40-43 (1979).
2. Weideman, E. and Van der Walt, L.T., *SAWTRI Techn. Rep.* No. 434 (Nov. 1978).

®Denotes registered trade marks. Dypenol 731-NF is the trade mark of Messrs Dexter Chemical Corporation, Bevaloid 4027 is the trade mark of Messrs Bevaloid S A (Pty) Ltd and Nonidet P40 is the trade mark of Messrs Shell Chemicals.

# APPENDIX



Sample of *Phormium tenax* curtaining

ISBN 0 7988 1969 3



**Published by**
**The South African Wool and Textile Research Institute**
**P.O. Box 1124, Port Elizabeth, South Africa,**
**and printed in the Republic of South Africa**
**by P U D Repro (Pty) Ltd., P.O. Box 44, Despatch**