OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

PRIVATE AND CONFIDENTIAL

18524

PRIVATE MEMO 589

CONTRACT 89/96

PROJECT DP/PHI/87/002

DEVELOPMENT OF PROCESSING TECHNOLOGY FOR INDIGENOUS FIBRES IN THE PHILIPPINES

PRETREATMENT, PREPARATION, AND SPINNING OF PINEAPPLE FIBRE

(FINAL REPORT)

by
A G RANKIN, R COLWELL,
AND W B SHANNON

JUNE 1990

COPY NO

6/ 77

LAMBEG INDUSTRIAL RESEARCH ASSOCIATION

Lambeg
LISBURN
Co Antrim BT27 4RJ

Tel: 0846-662255
Fax: 0846-661691

SYNOPSIS

The overall objective of this work was to determine whether Philippine pineapple fibre could be prepared and spun effectively using normal flax processing equipment.

Pineapple fibre or Pina was obtained from Philippine Textile Research Institute in two distinct forms, namely

(a) Decorticated (in which the adherent material has been removed from the pineapple fibre by mechanical means).

and (b) Degummed (in which the decorticated fibre had been wet treated to remove the gums from the fibre).

The decorticated fibre was hackled, spread and prepared on the traditional flax line system, and spun from sliver.

The degummed fibre was carded, using flax breaker and finisher cards, and subsequently combed and prepared using the normal flax tow system, (which is based on semi-worsted intersector preparation), followed by roving and spinning.

Both decorticated and degummed fibres have been dry-spun to counts around 110 tex, and have been wet-spun to counts in the region of 65 tex, using the type of equipment normally used by flax spinners.

It was originally thought that the flax line system of hackling-spreading-preparation, would produce finer and better yarns than the flax tow system of carding-combing. This has not proved to be the case; and it is our recommendation that further work on pineapple fibre should concentrate on degummed fibre, carded-combed, rather than decorticated fibre prepared on the line system.

The yarn counts achieved using 100% pineapple fibre, namely 110 tex dry-spun, or 65 tex wet-spun, would be suitable for incorporation in furnishing fabrics or medium weight dress goods. The use of 50% polyester (or acrylic) fibre extended the count range to the region of 40 tex, suitable for use as weft in lighter dress-goods. A sample length of fabric showing pineapple/polyester blend yarns wefted across a linen warp has been made and has been forwarded to PTRI.

A subsidiary objective of the work was to see if the degumming wet treatments could be improved. This work was extended to cover the wet treatment of fibre in rove form; this is how flax fibre is chemically treated when the fibre is in an appropriate mechanical state.

The wet treatments applied to fibre in rove form were generally felt to be more promising in terms of subsequent spinning performance than those on loose fibre. Two processing sequences were found which were felt to warrant further investigation. The use of softening agents and lubricants was successful in improving subsequent mechanical processing.

For clarity the Spinning (S) and Chemical Treatments (C) of the work have been reported in seperate sections of the report which cross references where necessary.

CONTENTS

Chemical Treatments: C

APPENDICES

*   *   *

REFERENCES

*   *   *

ACKNOWLEDGEMENTS

*   *   *

Section 1

GENERAL INTRODUCTION AND SUMMARY

In the Summer of 1988 LIRA was visited by senior staff members from the Philippines Textile Research Institute. This was part of their survey of Textile organisations likely to provide assistance in up-grading the fibres indigenous to the Philippines. Very useful discussions took place, and contacts were made.

Subsequently in February 1989 LIRA was visited by a senior member of UNIDO staff to discuss the possibility of undertaking work which would allow the potential of pineapple fibre to be assessed. Other indigenous fibres were discussed, but pineapple seemed to provide the best-fit for LIRA, with its long experience of dealing with the long staple flax fibres obtained from the stem of the flax plant.

LIRA was asked to tender for assessment work on the development of processing technology for indigenous fibres (ie pineapple fibre) and in due course was awarded a contract 89/86 dated 3 August 1989. The initiation of the work was delayed until pineapple fibre was delivered to LIRA at the end of November : the work programme actually started in December 1989.

In parallel with the work at LIRA, work on other indigenous fibres was going on at the University of Bradford; and both LIRA and Bradford also took part in the training of members of staff from the Philippine Textile Research Institute. Six members of PTRI staff have participated in the LIRA work at different times as part of the training.

The LIRA work programme split into two parts

(a) the chemical pretreatment of the fibre before the mechanical processing treatments involved in spinning.

(b) the mechanical treatments involved in making the fibre into yarn, using the long staple machinery employed by the flax industry.

In addition to these LIRA has also considered.

(c) the chemical pre-treatment of the fibre in rove form (ie in twisted ribbon form just prior to spinning).

There have already been two interim reports on the project.

LIRA Private Memo 579 (April 1990). Pre-treatments of Pineapple Fibre.

LIRA Private Memo 580 (April 1990). Preparation and Spinning of Pineapple Fibre.

The present Final Report is however relatively self-contained and does not specifically refer back to the Interim reports.

The two areas of work : Spinning and Chemical treatments are reported seperately in what follows for purposes of clarity. They are cross-referenced where necessary. Spinning paragraphs are given an "S" prefix, and Chemical work a "C" prefix.

<u>In Spinning</u> the specific objectives (outlined in the Terms of Reference for the work) were

(1) To produce dry-spun yarns of around 100 tex, and wet spun yarns around 65 tex, from 100% pineapple fibre.

(2) To assess the spinning limits (ie the finest counts) which could be spun from 100% pineapple fibre, and from 50:50 blends of pineapple/polyester, pineapple/viscose and pineapple/acrylic fibres.

The first objective has been met, and satisfactory yarns have been dry-spun to 100 tex (Nm 10) using 100% decorticated Pina fibre, prepared on the flax line system. Similar yarn count have been spun using 100% degummed Pina fibre, carded-combed-prepared on the flax tow system. In the case of wet-spinning, yarns have been spun to a count of 65 tex (Nm 16), using either 100% decorticated Pina long fibre, prepared on the flax line system, or alternatively, using 100% decorticated Pina machine tow, prepared on the flax tow system, or 100% degummed Pina fibre carded- combed- prepared on the flax tow system.

The second objective, namely to assess the spinning limits of 100% Pina fibre and 50:50 blends with polyester, viscose, and acrylic fibre, has been pursued as far as was practicable. It was found that the addition of viscose fibre to the pineapple fibre did not extend the spinning limits appreciably. However, blends using polyester or acrylic fibre were much more satisfactory and a total of some twenty-four 50/50 blends have been spun, as well as other samples using 10% and 20% of polyester fibre.

It was found possible to spin 50% Pina/50% Polyester, and 50% Pina/50% Acrylic fibre as fine as 30 tex (33 Nm) using wet spinning equipment normally used by flax spinners. These yarns would be suitable for incorporation as weft in fine apparel fabrics, although they would not generally be sufficiently strong or extensible to use as warp yarns.

In Chemical Treatment the objective of the LIRA preparative programme was to treat raw material so as to make it suitable for conversion into yarns with acceptable appearance, regularity and whiteness using flax spinning machinery. The methods employed were expected to show some benefit over existing pretreatment methods currently used in the Philippines, resulting in improved spinning performance, finer fibre and hence finer yarns, and/or better quality.

The work which was undertaken to pursue these objectives is detailed in Section C of this report. Some of the results are negative, some are reported as requiring further long term work, and some as reasonably possible improvements. The broad outline is given here.

An attempt to characterise the fibre and the impurities present, using infra-red spectroscopic techniques, did not produce any immediately significant results. Neither did the straightforward chemical processes such as are used for flax. In both cases the work might well be followed up on a longer term basis, possibly by PTRI.

The use of softening agents (in particular Belsoft K200) proved successful to a degree in improving subsequent mechanical processing. Fibre separation in preparing was better and a finer count of yarn was spun.

A series of wet treatments on loose fibre showed that suitable scouring could improve fibre handle. While alkaline treatments promoted "matting" of the fibre, acid treatments promoted general cleanliness. The best bleaching effect was obtained using Hydrogen Peroxide.

The wet treatments applied to fibre in rove form were generally felt to be more promising in terms of spinning performance than those on loose fibre. Treatments suitable for flax rove were tried on the pineapple rove, together with both alkaline and acid treatments. The overall conclusions for rove treatment seem to be roughly the same as for loose fibre.

The response to dyeing of the prepared fibre in rove and spun yarn was examined by applying different classes of dyes in comparative trials alongside bleached linen yarn, while the effect on dyeing behaviour of biocides, used to preserve damp fibre from microbial attack, was also studied.

Laboratory work was in many cases replicated by larger scale trials in pilot plant equipment used in wet processing of flax.

From the limited amount of work possible within the constraints of the project, two process sequences have emerged which should leave the fibre with reasonable whiteness and in a satisfactory condition for spinning, which merit further investigation.

These are:-

Sequence 1 : Fibre Treatment

- Acidify Decorticated Fibre
- Peroxide Bleach using Actiron PHD
- Apply Softening Agent

- Hydroextract
- Dry
- Card
- Comb
- Prepare
- Either dry spin from sliver
- or rove and wet spin

and

<u>Sequence 2</u> : <u>Rove Treatment</u>

- Soften Decorticated Fibre
- Hydroextract
- Dry
- Hackle
- Prepare Rove
- Boil
- Peroxide Bleach
- Wet Spin through lubricant

Section S/2

Spinning Section

INTRODUCTION

The preparation and spinning on flax machinery of yarns from pineapple fibre is described in this part of this report. It is subdivided in order to specify the different manufacturing sequences used for

(1) decorticated long pineapple fibre, which was hackled and prepared using the flax line system

(2) pineapple machine tow, which is a valuable by-product of the hackling process. This shorter fibre was processed using the system normally employed for flax tow.

(3) degummed pineapple fibre, which was also carded and processed using the system for flax tow.

S/3 LINE SYSTEM PREPARATION OF DECORTICATED PINEAPPLE FIBRE

S/3.1 Preliminary Trials The decorticated material was received in the form of a pressed bale containing individual "heads" or "stricks" of fibre, each weighing about 400 grams. Each head was lightly bound with a fibre band and, even when the binding was removed, the fibres adhered together and were matted at both ends.

In preliminary trials the fibre was mechanically softened by passing through a series of meshed fluted rollers, and was pieced-out (separated) by hand, and combed lightly using a hand hackle or roughers tool, a series of steel pins set in a wooden block. This hand-combed material was processed on a flax spreadboard, but did not draft satisfactorily, due to excessive inter-fibre adhesion. It was evident that machine hackling would be necessary, and that chemical pre-treatment would be advisable to soften the fibre and promote separation of the fibre bundles.

S/3.2 Chemical Pre-treatment Following a series of laboratory trials on small samples, reported elsewhere (in Part C) a wet treatment using 1% Belsoft K200 was applied to one batch of fibre, and a wet treatment using 2% Belfasin NP was applied to a second batch of fibre. These were intended for hackling trials, with untreated fibre as a control. Both lots of treated fibre hackled satisfactorily and both were notably softer than untreated fibre. In subsequent preparing the Belsoft treated material was preferred. The Belfasin treatment gave a fibre which was very soft, but was more difficult to handle.

S/3.3 Hackling Hackling is essentially a mechanical combing operation used to clean and separate scutched flax into two components, long fibre (line) and short fibre (tow). Scutched flax requires to be pieced-out by hand into portions, each about 100 grams, in preparation for hackling. Pineapple fibre, with or without a chemical pre-treatment, was pieced-out in a similar way, but required some additional manual preparation. This was done using the rougher's tool, to separate the tangled or matted ends of the bunches of decorticated fibre, before machine hackling.

Two different hackling machines situated in different spinning mills were used to hackle pineapple fibre. No machine adjustments were found necessary in either case. Machine details are given in paragraph S/3.5. The yield of long fibre was approximately 50%. The remaining short fibre, or tow, was not waste, but was suitable for carding and further processing in the two system, as described in Section S/4 of this report.

S/3.4 Processing Sequence The processing sequence used to prepare the samples made from decorticated pineapple fibre is illustrated in the flow chart diagrams overleaf, and the hackling and preparing specifications which follow in paragraph S/3.5.

DECORTICATED PINEAPPLE FIBRE

PROCESSING SEQUENCE USED AT LIRA

CHEMICAL PRE TREATMENT AND DRYING (OPTIONAL)

MANUAL DRESSING TO OPEN THE TANGLED ENDS (ESSENTIAL)

PIECING-OUT (A NORMAL PREPARATORY OPERATION TO FACILITATE HACKLING)

HACKLING COMBING, SUBDIVIDING AND CLEANING THE FIBRE. THIS OPERATION YIELDS TWO DIFFERENT END PRODUCTS.

LONG PINA FIBRE
CLEAN PARALLEL

- HAND-SPREADING OR AUTO SPREADING
- SCREWGILL PREPARATION
  LINE DOUBLER
- 1ST DRAWING
- 2ND DRAWING
  (BLENDING WITH SYNTHETIC)
- 3RD DRAWING
- 4TH DRAWING
- DRY SPINNING
- ROVING
  - ROVE TREATMENT
  - WET SPINNING

SHORT FIBRE - TOW
TANGLED

- CARDING TO FORM SLIVER
  (FLAX FINISHER CARD)
- TOW PREPARATION
  SEMI-WORSTED SYSTEM
- PRE-COMB DOUBLING
  (INTERSECTOR)
- COMBING
- 3 INTERSECTOR DRAWINGS INCLUDING BLENDING WITH SYNTHETIC FIBRE
- DRY SPINNING
- ROVING
  - ROVE TREATMENTS
  - WET SPINNING

S/3.5 HACKLING SPECIFICATION

The hackling machine used for the decorticated pineapple fibre was a normal 14 head flax hackling machine, situated in a mill in Northern Ireland, and in commercial use daily. No adjustments were found necessary when processing the pineapple fibre, after the pineapple fibre had been hand-dressed and pieced-out correctly.

Production rate: 180 lbs/hour.
8 lifts/minute

Pins/Inch

Head No Pins/inch	1 0.5	2 0.75	3 1	4 1.5	5 2	6 3	7 4.5
Head No Pins/inch	8 6	9 8	10 11	11 13	12 20	13 25	14 35

Preparing System - Typical Drafts and Doublings

	Doubler	1st Drg	2nd Drg	3rd Drg	4th Drg	Roving
Drafts Doublings	12 12	10 8	8 8	8 6	8 4-6	10 1

S/3.6 LONG FIBRE PREPARATION AND SAMPLE SPINNING

.1 100% Pineapple (Pina) Fibre

Two batches of decc :icated fibre were chemically softened by treatment (see C/3.3)

(a) 1% Belsoft K200
(b) 2% Belfasin NP

and were dried at low temperature before hand dressing on the rougher's tool, and piecing out for hackling.

Two batches of decorticated fibre, with no chemical pre-treatment were similarly hand dressed and pieced-out for hackling.

These four batches of fibre were hackled on a normal 14-tool flax hackling machine. No problems were encountered. The yield of long pineapple fibre was approximately 50% in all cases, whereas a yield of 60% long fibre would be expected in hackling flax. The short pineapple fibre (tow) removed by the hackling machine was suitable for carding in a flax finisher card, and was used to prepare yarn samples as indicated in section S/4 of this report.

The hackled pieces of long pineapple fibre were clean and parallel, and were of suitable length to be formed into continuous sliver using a normal flax spreadboard. For sample purposes, a manual spreadboard was used, but the hackled pina fibre could equally well have been formed into sliver using an automatic spreadboard fitted to the hackling machine.

Normal screwgill line drawing frames were used for the doubler, first and second drawing operations. A screwgill tow drawing frame was used for the third and fourth drawing stages in order to shorten the fibre for dry-spinning. A flax tow roving frame was used to make rove for wet-spinning trials.

Fibre fineness tests were carried out at the beginning and end of the preparing sequence to assess the amount of fibre bundle subdivision which had occurred during processing.

The decorticated pina fibre, with no chemical softening before hackling, progressed from 62 decitex at the first drawing stage to 32.5 decitex at the first drawing stage to 32.5 decitex at the finisher drawing stage.

The decorticated pina fibre which had been treated with 1% Belsoft before hackling progressed from 52 decitex at first drawing to 27.7 decitex at the finisher drawing.

These figures indicate that the softening treatment with the Belsoft has contributed to some degree of fibre subdivision during hackling and preparation over pins. The 2% Belfasin treatment gave a slippery fibre which was difficult to process in sliver form, due to poor cohesion. This fibre was not spun.

S/3.6.2 Dry Spinning, 100% Long Pina Fibre

The untreated hackled long pina fibre could be dry-spun as 100% Pineapple fibre to the target count of 102 tex (9.8 Nm), and the Belsoft treated fibre could be spun to 98 tex (10.3 Nm), with a satisfactory spinning performance, using a normal Mackie dry-spinning frame with apron and roller drafting control in the reach. This count, (approx 10 Nm), is similar to the dry-spinning limit for flax tow spun on this type of frame. The yarns produced were more hairy and more harsh in handle than flax yarns. They would be more suitable for open-weave furnishing fabrics than for apparel fabrics. The softened fibre yarn was less harsh than the untreated material, but was still rather more hairy than flax yarn. The use of Belsoft prior to hackling did not extend the spinning limit appreciably, but it gave a softer and less harsh yarn.

S/3.6.3 Wet spinning of 100% long pina fibre

The 100% hackled pina fibre was roved to a weight of 90 yds/oz, and was wet-spun to the target count of 65 tex (Nm 15) using a Mackie open-reach wet spinning frame, with the reach extended to 3.25", which is an abnormally high reach for this type of frame. Drafting was difficult, and it was necessary to use very high roller pressure. Thus, although the original aim of the project was achieved, namely to spin 65 tex from grey (untreated) pineapple fibre, we would regard this as being a difficult spinning operation.

Chemical tests on pineapple fibre indicated that the weight loss on a water boil was approx 7.5% and the weight loss in a standard caustic boil was approx 26.5%. These figures are comparable with those obtained from slightly under-retted flax, which is frequently treated in rove form to improve its wet-spinning performance. Thus, a series of rove treatments based on a caustic boil followed by a peroxide bleach (which have become well-established commercial processes for flax) were applied to 100% pineapple fibre rove. These did not give any major improvement in spinning performance (although boil/peroxide treatments were subsequently found to be effective on 50/50 polyester/pina blends). (Ref Section C/4.4).

Alternative rove treatments using an acidic scour instead of the usual caustic boil were also investigated with little success initially. In very recent trials however, carried out after the project was officially concluded, a better spinning performance has been obtained by using a softener/lubricant in the spinning trough itself. This trough additive, 5g/litre of CERANINE AS, has aided the spinning of both grey rove, and also of chemically treated bleached rove made from 100% Pineapple long fibre. (Ref Section C/4.4 and C/4.5).

This area of work is incomplete, but the results are encouraging. There is sufficient potential to justify further study as a follow-on project.

S/3.6.4 Long fibre pineapple/polyester blends

Long pineapple fibre sliver was blended with polyester in the ratios 90:10, 75:25 and 50:50, on the normal line screwgill drawing system. The 90% pina/10% polyester could be wet spun to 55 tex (Nm 18) at 3.5" spinning reach. The 75:25 blend could spin to 55 tex (Nm 18) at 3" reach and could be spun as find as 40 tex (Nm 25) at 3.25" reach.

A standard boil/peroxide rove treatment applied to the 50/50 blend allowed satisfactory yarn to be spun as fine as 35 tex (Nm28).

The same rove treatment applied to 75:25 pina polyester gave a satisfactory spin at 40 tex (Nm25). A small quantity of this yarn has been wefted across a linen warp for examination.

Thus, although the addition of 10% polyester made only a small improvement in wet spinning, the use of 25% or 50% polyester extended the spinning limits to counts which could be used for apparel fabrics.

All the 50/50 pina/polyester samples had tenacities ranging from 11 gf/tex to 13 gf/tex. Such yarns would be suitable for weft rather than warp, in high-speed weaving.

S/3.6.5 Long fibre pineapple/acrylic blends

Hackled pineapple fibre sliver was blended with acrylic tops, in 50:50 ratio, on the normal screwgill system.

Two small quantities were dry-spun from sliver.

(a) 105 tex (Nm9) giving a satisfactory spin but a low strength of 591 gms, a tenacity of 5.6 gf/tex

(b) 67 tex (Nm 15) with a strength of 483 gms, tenacity 7.2 gf/tex.

The bulk of the hackled pina/acrylic sliver was roved and wet-spun. The untreated fibre blend was spun to counts of 55 tex (Nm 18) and 44 tex, (Nm 23). The blend containing the softener pina fibre was spun to 67 tex, 52 tex, and 43 tex, metric counts of Nm 15, Nm 19 and Nm 26 respectively.

The wet-spun yarns were fine enough to be incorporated into apparel fabrics, as weft, but were not, in our opinion, strong enough to use as warp yarns in high-speed weaving. The tenacities of the pina/acrylic blend yarns (8 to 9 gf/tex), were somewhat lower than the pina/polyester blends described in S/3.6.4.

Section S/4 Tow System Preparation and Spinning of Degummed Pineapple Fibre, and Machine Tow

S/4.1 Raw Material The degummed fibre was very compacted and damp as received, with a moisture regain of 32%. It had been delayed in transit, and kept in the pressed pack much longer than had been intended. Before any trials could proceed, it required to be opened, spread, and turned to allow it to condition to approx 15% regain. A small quantity was oven-dried, opened by hand, and spread lightly on a flax finisher card. This was not satisfactory since the long strands of compacted material pulled in through the feed, and were not carded successfully. It was apparent that pre-opening using a breaker card would be necessary for the degummed material.

S/4.2 Carding A flax breaker-card was used to open the compacted strands of degummed fibre. There was very little loss of fibre at breaker-carding, since any fibre which did not emerge as an open fleece could be recovered from the pit beneath the card, and could be re-processed.

The opened fibre was then suitable for carding on a standard flax finisher card. The small Mackie card at LIRA was used for the trials, but a larger card such as the Mackie 5X could equally well be used for larger quantities of fibre.

The machine tow, derived from the hackling process applied to the decorticated pineapple fibre, was suitable for finisher carding without any further preparation. Fibre loss during carding was about 8%.

S/4.3 Preparation and Combing The carded sliver was given one pre-comb doubling, using the semi-worsted intersector gill box, at LIRA.

Combing was carried out at a Spinning Mill, using Schlumberger combs. Fibre losses during combing amounted to 20% for machine tow and 30% for degummed fibre. The combing process itself was satisfactory as far as removal of nep was concerned. It is thought that the fibre loss might be reduced somewhat by better pre-comb preparation.

Post-comb drawing, and blending with synthetic fibre, were also carried out using the LIRA intersector gill box system.

S/4.4 Spinning

4.4.1 Machine Tow, Uncombed Some of the carded machine tow fibre was processed without combing, and was blended 75% Pineapple/25% Polyester. This material was dry-spun to counts of 80 tex and 40 tex (Nm 12.5 and Nm 25 respectively). The spin was satisfactory, but the yarns were excessively hairy.

The uncombed material blended with polyester was also roved and wet-spun, to counts of 60 tex, 30 tex and 25 tex, (Nm 16.5, 33, and 40) but all the yarns were very neppy, due to the use of uncombed tow. Neps are small hard lumps of entangled fibre in the yarn. The yarns made from uncombed pineapple fibre could possibly be used as "effect" yarns but would have very limited commercial outlets.

S/4.4.2 Machine Tow, Combed

(a) Dry Spinning The combed machine tow (100% pina fibre) could be spun, dry, to a count finer than the target count of 110 tex (Nm 9). A good spin was obtained at 85 tex (Nm 12) but it would not spin satisfactorily to 65 tex (Nm 15).

When blended 90% pina/10% polyester, good spins were obtained at 65 tex (Nm 15).

Blends of 75% pina/25% polyester could be dry-spun as fine as 55 tex (Nm 18).

Blends of 50% pina/50% polyester could be dry-spun as fine as 42 tex (Nm 24).

These represent the dry spinning limits for combed pina machine-two/polyester blends.

(b) Wet Spinning In wet-spinning, the 50/50 pina machine tow/polyester blend could be spun to counts finer than 40 tex, Nm 25.

A 50/50 blend of pina machine tow/acrylic fibre could be spun to 46 tex (Nm 22).

S/4.4.3 Degummed Pineapple, Double Carded, Combed

(a) Dry Spinning Degummed, carded, combed pineapple fibre, 100% could be spun, dry, to a count finer than the target of 110 tex (Nm 9).

A good spun was obtained at 85 tex, but it would not spun as fine as 65 tex (dry).

When blended 75% Pina/25% Polyester, a good spin was obtained at 55 tex, (Nm 18) using the Mackie dry-spinning frame.

These results are similar to those obtained with the pina machine-tow blends.

Degummed, carded, combed pina fibre, blended 50/50 with acrylic fibre, was dry-spun to a count of 82 tex, (12 Nm). This is finer than the count which was achieved using hackled long pina fibre, blended 50/50 with acrylic fibre.

S/4.4.3 (b) Wet Spinning (of degummed pina) 100% degummed pineapple fibre, double carded, combed, prepared on the semi-worsted intersector system, roved using a flax tow roving frame, was spun to a count of 82 tex (Nm 12) on the Mackie open-reach wet spinning frame.

When blended 50/50 with polyester, the degummed combed pina blend was wet-spun to 40 tex (Nm 25) and also to 28 tex (Nm 36) with yarn tenacities of 13.5 and 11.5 gf/tex respectively.

Degummed combed pina fibre, blended 50/50 with acrylic fibre, could be wet-spun as fine as 28 tex (Nm 36) with a yarn tenacity of over 9 gf/tex. When spun to a count of 33 tex (30 Nm) using the new Mackie "Linmack" drafting system, a tenacity of 12 gf/tex was obtained, but in general the wet-spun pina/acrylic yarns had tenacity in the region of 9 gf/tex ie they were slightly weaker than the pina/polyester equivalent yarns.

Only one wet-spun 50/50 pineapple/viscose blend yarn was wet-spun, to 72 tex (Nm 15) with tenacity of 7.2 gf/tex. In general, pina/viscose blends were not found to be as satisfactory as either pina/polyester or pina/acrylic blends.

Section S/5

SUMMARY

(1) Decorticated Pineapple fibre requires some hand combing or dressing to render it suitable for machine hackling on standard flax hackling equipment. When properly prepared, it hackles satisfactorily.

(2) Pre-treatment with a non-ionic softener, before hackling, gives a softer handle, and appears to help in fibre subdivision during preparation on a screwgill line system.

(3) 100% Decorticated pineapple may be dry-spun, using standard Mackie dry spinning equipment, up to and beyond the target count of 100 tex (Nm 10).

(4) 100% Decorticated pineapple may be wet-spun to a count of 65 tex (NM 15) but it requires high roller pressure, and also require the spinning reach to be extended to 3.25", on a normal open-reach Mackie spinning frame. We were not able to spin 100% long pina fibre on the new Linmack wet-spinning system.

(5) Standard rove boiling/bleaching treatments, normally used for flax, have not extended the wet spinning limits appreciably. Further non-standard treatments were investigated, with limited success. In very recent trials, an additive in the spinning trough has been found to be advantageous. This would require further work.

(6) The addition of 25% polyester to long pina fibre extended the wet-spinning limit to 55 tex, (Nm 18).

(7) The addition of 50% polyester to long pina fibre extended the wet-spinning limit to 40 tex (Nm 25).

(8) Degummed pineapple fibre may be processed using flax breaker card, flax finisher card, flax combs, and semi-worsted intersector gill-box drawing as used in the flax tow system.

(9) The pineapple "machine tow" derived from hackling decorticated pineapple fibre may be processed as in (8) above (but it does not require breaker carding).

(10) The above fibres may be spun without combing, but the resultant yarns are excessively hairy or neppy, and in practical terms combing is essential.

(11) The carded combed pina fibre, whether decorticated or degummed, may be dry-spun on standard flax spinning machinery to counts finer than the target value of 100 tex (Nm 10).

(12) When blended with 50% polyester, the combed pineapple fibres may be dry spun as fine as 42 tex, (Nm 24). This count is sufficiently fine to be used for apparel fabrics.

(13) When blended with 50% polyester, the combed pineapple fibre could be wet-spun finer than 40 tex (Nm 25). The yarn appearance was markedly smoother than the dry-spun 42 tex blend.

(14) Combed pina fibre, blended 50/50 with acrylic fibre, may be wet spun as fine as 28 tex, (Nm 36). Pina/acrylic blend yarns are slightly weaker than pina/polyester yarn of the same count.

(15) The strength of the fine count blend yarns is probably not sufficiently high to allow them to be used effectively as warp yarns. They have, however, been used as weft across a flax warp, and could equally well be wefted across a polyester/cotton warp, to produce acceptable lightweight shirting or blouse fabrics.

SECTION C/2

CHEMICAL TREATMENT SECTION

INTRODUCTION

The work involved chemical pretreatment of the decorticated, washed fibre

(a) in fibre form as received from PTRI, and
(b) in rove form

The work in (a) was to see if any improvements over existing methods could easily be found. The work in (b) was added because this is where chemical treatment of flax fibre usually takes place since the fibre is in a suitable physical form for treatment: it was appropriate to consider pineapple fibre in the same way.

Some preliminary work was done on characterisation and purification of the pineapple fibre.

.1 Characterisation of pineapple fibre

Infra-red spectra using a Perkin-Elmer 983G IR spectrophotometer interfaced with a P-E 3600 IR data station were obtained from decorticated and washed pineapple fibres subjected to various treatments:-

- untreated (control)
- boiled in 10% soda ash + 2% caustic soda, both calculated on weight of fibre, hereafter "owf"
- bleached using 1 volume hydrogen peroxide at 85°C
- bleached using cold alkaline hypochlorite (1.5 g/l available chlorine)

- bleached using 1 g/l sodium chlorite, pH 4.5 at 95°C.
- treated with 5 g/l Trilon TB at 95°C then bleached with cold alkaline hypochlorite
- treated with 5 g/l sodium dithionite (Hydros) at 70°C
- as treated by Philippine Textile Research Institute (caustic soda + sodium bisulphite)

In addition IR spectra were run on

- portions of pineapple leaf from top, middle and base
- pure cellulose samples
- lignin from different sources
- pectin from different sources.

The spectra obtained are reproduced in Appendix 1, and from them it can be seen that no significant aid is afforded towards the identification of the impurities which may be present.

.2 Purification of pineapple fibre

A technique used for the systematic chemical removal and estimation of impurities from flax was applied to decorticated and washed pineapple fibre. The moisture content of the substrate was found to be 11.8% when conditioned at 20°C and 65% relative humidity.

(i) Soxhlet extraction in carbon tetrachloride to remove waxes, followed by treatments in turn:-

(ii) 6 hour water boil to remove water-soluble matter;

(iii) 6 hour boil in 5 g/l ammonium oxalate to remove pectin;

(iv) 6 hour boil in 20 g/l caustic soda to remove hemicelluloses;

(v) lignin removal by successive sodium hypochlorite treatments as detailed in Appendix 2.

Problems were encountered using thimble filters which led to difficulties in replication. In order to maximise available time at LIRA it was recommended that this procedure be further investigated at PTRI.

C/3. WET TREATMENTS ON DECORTICATED, WASHED PINEAPPLE FIBRE

Trials were carried out at liquor to goods ratio of 15:1 using a variety of chemical treatments in an effort to present the fibre in a cleaner, whiter state, more amenable to subsequent yarn production.

C/3.1.1 Scouring Treatments for 1 hr at 95°C in

(a) 2 g/l soap flakes
(b) 2 g/l Strodex V44
(c) 2 g/l Warcodet K25

gave slight improvement in colour and softer handle. Sample (a): PF10 had a fluidity of 7.3 when tested according to BS 3090: 1978 (1986). Weight losses on boiling in 20 g/l caustic soda were ascertained and revealed that scouring removed 2.5% of fibre weight.

C/3.2.2 Alkalies

Treatment for 1 hr at 95°C in

(a) 5 g/l disodium phosphate
(b) 5 g/l tetrasodium pyrosphosphate
(c) 5 ml/l ammonia
(d) 10% owf soda ash
(e) 10% owf soda ash + 2% owf caustic soda.

Treatment (e) produced the best shade and lost most weight - 7.8%. Fluidity was 4.1 (untreated control 3.6). Fibre became progressively more matted from (a) to (e).

Further treatments examined the effect of time and concentration.

(f) Effect of time When fibre was treated in 10% owf soda ash + 2% owf caustic soda for 1, 2 and 3 hours at 95°C the degree of greying of shade and of fibre/fibre adhesion increased with duration of treatment.

(g) Effect of concentration When 50 g/l (ie 5% solution) caustic soda + 5 g/l (0.5% solution) sodium bisulphite were used at 95°C the degree of matting was greater than with 5% owf caustic soda + 0.5% owf sodium bisulphite.

Rinsing off samples in 10 ml/l acetic acid at 40°C improved shade and reduced matting.

C/3.1.3 Acids

(a) 5 g/l monosodium phosphate: 1 hour at 70°C
(b) 30 ml/l acetic acid. 1 hour cold.
(c) 5 ml/l acetic acid. 1 hour at 95°C
(d) 10 ml/l acetic acid. 1 hour at 95°C
PF8 Fluidity 8.6
(e) 5 ml/l formic acid: 1 hour at 95°C

(f)	5 g/l oxalic acid: 1 hour at 70°C	
(g)	10 ml/l hydrochloric acid.	1 hour cold
(h)	" "	30 min at 50°C
(i)	" "	1 hour at 50°C PF 12 Fluidity 7.3
(j)	" "	30 min at 70°C
(k)	" "	1 hour at 70°C

Fibre became progressively cleaner and less matted.

C/3.1.4 Sequestrants

(a) 5 g/l Trilon TB: 1 hour at 95°C gave shade similar to that using soap flakes (2.3.1 a), soft fibre and lost 1.6% in weight.

(b) 2 g/l Calgon: 1 hour at 95°C gave some fibre/fibre adhesion.

C/3.1.5 Reducing Agents

(a) 5 g/l sodium dithionite (Hydros): 1 hour at 70°C followed by oxidation in 2 g/l sodium perborate at 50°C.

(b) 5 g/l Formosul: 1 hour at 95°C oxidised as (a)

(c) 5 g/l soda ash + 5 g/l sodium dithionite: 1 hour at 95°C oxidised as (a)

(d) 10 g/l caustic soda + 5 g/l sodium dithionite: 1 hour at 70°C oxidised as (a)

While the shade of the fibre improved on treatment, the material from (c) and (d) was weak and matted.

C/3.1.6 Oxidising Agents

(a) 1 volume hydrogen peroxide (stabilised with 5 g/l soda ash + 4 g/l sodium silicate). 1 hour at 85°C gave a yellowish white shade with some fibre/fibre adhesion.

(b) Alkaline hypochlorite (1.5 g/l available chlorine). 2 hours cold. Antichlor with sodium bisulphite. Fibre soft, greyish shade.

(c) Acid hypochlorite (5 g/l available chlorine) pH 5. 45 mins cold produced a brownish shade on less matted fibre.

(d) 1 g/l sodium chlorite pH 4.5. 1 hour at 95°C gave shade like (a); fibre less matted.

(e) 1 g/l potassium permanganate and 0.5 m/l sulphuric acid: 1 hour cold. Clearing either in sodium bisulphite or in hydrogen peroxide gave slightly matted fibre.

C/3.1.7 Enzyme

3 ml/l Rucolase CEL, an aqueous solutin of microbial cellulase, + 0.5 ml/l Rucogen SAS, a low-foaming wetting anxiliary. pH5 : 1 hour at 55°C. Fluidity 5.9. Similar degrees of fibre separation were obtained by this treatment and by a control carried out at pH5.

C/3.1.8 Low liquor ratio treatments

These were expected to minimise fibre entanglement although subsequent wash off counteracted the effect to some extent.

Fibre was impregnated at room temperature with sodium chlorite liquors and hydrogen peroxide liquors varying the concentrations of the ingredients. The treated fibre was hydroextracted and batched in polythene for 24 hours at room temperature before washing off. The recipes giving optimum results in each case are reported.

(a) 20 g/l sodium chlorite + 3 g/l soda ash + 1.8 g/l paraformaldehyde gave well separated fibre, and less well bleached than by conventional chlorite.

(b) 77 ml/l hydrogen peroxide (130 vol) + 15 g/l sodium silicate + 8 g/l caustic soda gave a satisfactory bleach with the fibre in good condition.

C3.1.9 Conclusions The fibre as received was matted to some extent. As the result of this preliminary work it became clear that treatments under acid conditions generally leave the fibre in a better state than those with alkali which tend to promote matting. Hydrogen peroxide gave the best bleaching effect. Subsequent modifications of the peroxide bleach are reported under C/3.2.

C/3.2 MODIFIED PEROXIDE BLEACHING OF DECORTICATED PINEAPPLE FIBRE

In view of the effect of alkaline treatments on fibre/fibre adhesion, modifications in peroxide bleaching were undertaken.

.1 A control bleach was carried out with hydrogen peroxide and 5 g/l soda ash + 4 g/l sodium silicate, heating slowly to 85°C and giving 2 hour at 85°C then hot and cold washes.

.2 Use of Stabiliser SIFA (Sandoz) - a non-silicate stabiliser

(a) 5 g/l was added to 1 volume hydrogen peroxide with 4 g/l caustic soda and bleached as control.

The fibre was less white than control with similar degree of matting.

(b) The procedure was repeated on fibre pre-scoured in 5% owf caustic soda + 0.5% owf sodium bisulphite for 2 hours at the boil. While the shade was whiter than (a) the fibre was considerably matted.

.3 Use of Actiron ABO (Protex) - a stabiliser of acid peroxide:

(a) 1 volume hydrogen peroxide + 1 g/l caustic soda + 3 ml/l Actiron PHD + 2 g/l ammonium persulphate. Heat slowly to 85°C and give 45 mins at 85°C then add 3 ml/l Actiron ABO and continue treatment for further 15 mins.

(b) As (a) omitting ammonium persulphate.

(c) As (a) but using 6 ml/l Actiron ABO.

Actiron treatments gave lower white but less matted fibre than control.

C/3.3 SOFTENING AGENTS ON PINEAPPLE FIBRE

Preparation of rove from decorticated pineapple fibre as received proved difficult due to adhesion between adjacent fibres.

.1 Proprietary softening agents representing different chemical classes were dissolved in distilled water and applied at 15:1 liquor to goods ratio as detailed in Table 1, then hydroextracted, dried, conditioned and assessed by hand for softness.

TABLE 1: SOFTENING AGENTS ON PINEAPPLE FIBRE

Product	Classification	Application	Softness Rating
Alcamine 544 spec	Cationic	3% owf at 40°C pH 5.5. - 6	2nd best
Crosoft AM-FO	Amphoteric	2% owf at 50°C	4th best
Belsoft K200	Nonionic	1% owf at 40°C	5th best
Persoftal SWA	Anionic + Silicone	4% owf at 35°C	3rd best
Solusoft WA	Silicone elastomer	3% owf cold	Best
Control		Water at 40°C	Worst

On passing over pins in the rougher's tools all the softened samples evidenced improved fibre separation compared with the control.

.2 As the nonionic softening agent was considered to give rise to less problems in subsequent wet processes, 871 g of decorticated pineapple fibre was treated in a Pegg package dyeing machine (8 litres capacity) with 1% owf Belsoft K200 for 30 min at 40°C, hydroextracted and dried. Fibre fineness was slightly better than unprocessed fibre and yarn was spun to 66 tex (15 Nm).

.3 On the basis of this 30 lb decorticated fibre was similarly treated, hackled at a LIRA member's works and wet spun alone and with 10%, 25%, and 50% polyester. While the fibre was softer and finer than untreated material, it did not permit spinning limits to be extended.

.4 778 g of ungummed pineapple fibre which had been treated with caustic soda and sodium bisulphite at PTRI was also softened with Belsoft K200. No spinning trials were carried out.

.5 Cationic proprietary products: 3% owf Ampital SD + 2% owf Belfasin NP (as stock of Alcamine 544 special was insufficient) were applied to 60 lb of decorticated pineapple fibre for hackling and spinning. The treated fibre was too slippery for preparing and spinning.

C/3.4 LIGNIN CONTENT

Pineapple fibre is more highly lignified than flax. Contents varying from 4.4% to 12.7% have been quoted, as against 2.2% for flax. The presence of lignin is believed to contribute to the low fastness to light of the yarn made from bleached rove - a rating of 3 was obtained on a sample wet spun from boil - peroxide preparation.

An acid hypochlorite (3 g/l available chlorine) at pH 4.5, for 45 mins cold was given to decorticated pineapple fibre and after washing off cold, portions were treated as follows:-

(a) 1 g/l sodium bisulphite for 20 mins cold. Light brown shade resulted with good fibre separation. PF15/1: fluidity 6.8.

(b) 10% owf soda ash for 1 hour at boil, washed off hot and cold gave a medium brown shade, with some fibre matting. Similar results were obtained using 2% owf caustic soda and a combination of both alkalis. PF 15/5: fluidity 5.7.

(c) 1 volume hydrogen peroxide stabilised with 5 g/l soda ash and 4 g/l sodium silicate gave the whitest shade of this series with some fibre matting.

Assessment of lignin content was attempted using microscopic examination of material stained with phloroglucinol/hydrochloric acid. Whereas the jute control gave overall red colouration and flax showed discrete colour areas, pineapple fibre was virtually unstained. This result is surprising, but time did not permit further investigation, and additional work is required.

C/4 WET TREATMENTS ON ROVE PREPARED FROM DECORTICATED FIBRE

Single bobbins each containing 400 grams rove (density 0.35 g/cc) from decorticated, washed pineapple fibre were processed in the Pegg Machine.

C/4.1 Standard flax rove process (Trial P8)

Boil: 1 hour at 95°C in 10% soda ash + 2% caustic soda + 1.4 ml/l Trilon TB (to cater for hardness of water supply). Alternate flow in → out; out → in.
Washed hot and cold.
The resultant package was extremely hard and did not spin satisfactorily. It was then sent for a peroxide treatment.

Peroxide: 1 vol hydrogen peroxide + 5 g/l soda ash + 4 g/l sodium silicate + 1.4 ml/l Trilon TB. Flow out → in only. Raise temperature to 85°C and run 1 hour at 85°C. Hot and cold washes.

Package was still hard and did not spin satisfactorily. It was sent for a chlorite treatment.

Chlorite: 1 g/l sodium chlorite + 1 g/l sodium nitrate at pH 4.5. Temperature raised to 90°C and run 1 hour at 90°C. Washed cold. Package was still hard, and did not spin satisfactorily.

In a second trial (P10), four rove bobbins were bleached by boil-peroxide. One bobbin was softened with 1% owf Belsoft K200 for 30 min at 40°C while two were given chlorite. None of these gave satisfactory spin.

C/4.2 Organic Acid - modified peroxide bleach

Pre-treat: 30 min at 70°C in 5 g/l formic acid.
Wash well.

Peroxide: 1 vol hydrogen peroxide
1 g/l caustic soda
3 ml/l Actiron PHD
1 ml/l Synperonic N
2 g/l ammonium persulphate
1.4 ml/l Trilon TB

Heat slowly to 85°C and give 45 min at 85°C, then add 3 ml/l Actiron ABO and continue treatment for further 15 mins.

Spinning Trials proved unsatisfactory.

C/4.3 Organic Acid - acid hypochlorite bleach

(a) Pretreat : As .2 above

Bleach : Acid hypochlorite (5 g/l available chlorine) pH 5.
45 min cold. Wash cold.

Antichlor : 1 g/l sodium sulphite. 30 min cold. Wash cold.

Peroxide : 0.5 vol hydrogen peroxide + 2 g/l soda ash + 1 g/l sodium silicate.
30 min at 85°C. Wash well.
Rove was low in strength.

(b) A second bobbin was pre-treated as (a) and bleached in half-strength hypochlorite followed by antichlor : no peroxide.
This rove did not draft satisfactorily.

C/4.4 Mineral acid - peroxide

Trial 4/6

Pretreat : 1 hour at 50°C in 5 ml/l hydrochloric acid. Wash cold.

Peroxide : 2 vol hydrogen peroxide
2 g/l tetrasodium pyrophosphate
1.4 ml/l Trilon TB
5 hr at 50°C. Wash off.

As the shade was low, a further peroxide tretment was given:-

0.5 vol hydrogen peroxide
5 g/l soda ash
4 g/l sodium silicate
1.4 ml/l Trilon TB
1 hour at 85°C. Wash well.

This did not spin well. Drafting was facilitated by adding an amphoteric lubricant (5 g/l Ceranine AS) to the spinning trough at 60/65°C.

Spinning performance seemed to be improved but more work is required to establish this.

<u>Trial 13/16</u>

Pretreat	:	As Trial 4/6
Peroxide	:	1 vol hydrogen peroxide
		5 g/l soda ash
		4 g/l sodium silicate
		1.4 ml/l Trilon TB
		90 min at 85°C

This was spun through Ceranine AS but was more difficult to draft than Trial 4/6.

C/4.5 <u>Mineral acid - alkaline scour</u>

<u>Trial 21/6</u>

Pretreat : 1 hr at 70°C in 5 ml/l hydrochloric acid. Wash well.

Scour : 1 hr at boil in 5 g/l soda ash + 2 g/l Warcodet K.

This too was spun through Ceranin AS but spinning proved unsatisfactory.

To comment on this whole section (C4); it appears that the use of lubricant in the spinning trough is advantageous, and in view of this the earlier work should be repeated.

C/5 DYEING Pineapple is a cellulosic fibre and dyes with similar colours to those used for other cellulosics such as cotton and linen. Typical dyestuffs from several dye classes were applied both to wet spun pineapple yarns and to bleached linen yarns.

C/5.1 Direct Colours These are water soluble substantive dyestuffs which are exhausted on to cellulosic fibres by additions of electrolyte. 1% owf dyeings of

Solophenyl Orange ARL - Colour Index Direct Orange 106 - Society of Dyers and Colourists Classification A.

Solar Blue 3G - CI Direct Blue 78 - SDC Classification B.

Chloramine Fast Scarlet 4B - CI Direct Red 23 - SDC Classification C

were carried out at a series of different dyeing temperatures: 35°C, 65°C, 95°C with and without 10% owf common salt.

The behaviour of the dyes on pineapple was similar to that on linen. In all cases appearance, yield and levelness improved with rising temperature. Blue 3G was strongly influenced by salt at 35°C and 65°C. Scarlet 4B had lowest salt sensitivity, yield increasing with temperature. Depth and brilliance of shade on the pineapple fibre compared favourably with the dyeings on the linen yarn.

C/5.2 Reactive colours These are water-soluble dyestuffs which form a covalent lirkage with cellulose giving a high level of wet fastness in dyed materials. Prior to dyeing, yarns were rinsed in 1 ml/l acetic acid to ensure freedom from alkali, the presence of which might have resulted in premature fixation.

.1 Cold dyeing colours 1% dyeings of

Procion Yellow MX4R - CI Reactive Orange 14
Procion Red MX5B - CI Reactive Red 2
Procion Blue MX2G - CI Reactive Blue 109

were carried out at room temperature using 45 g/l common salt and 10 g/l soda ash, then soaped at the boil.

The dyeings were level - those on pineapple being duller in shade than those on linen.

.2 Warm dyeing colours 1% dyeings of

Remazol Brilliant Yellow GL - CI Reactive Yellow 37
Remazol Brilliant Red F3B - CI Reactive Red 180
Remazol Brilliant Blue R - CI Reactive Blue 19

were carried out at 60°C with 50 g/l common salt with 5 g/l soda ash in pyramid additions. After dyeing for 90 min the samples were rinsed in cold water then in 1 ml/l acetic acid at 50°C followed by hot water then 2 min in boiling water.

Results were similar to (a).

.3 Hot dyeing colours 1% dyeing of

Drimarene Brilliant Green X-3G CI Reactive Green 12.
Procion Red H8BN - CI Reactive Red 58
Procion Golden Yellow HR - CI Reactive Orange 12
Procion Turquoise HA - CI Reactive Blue 71

were carried out at 85°C with 60 g/l common salt and 10 g/l soda ash, washing off and soaping at the boil. Results were similar to (a).

C/5.3 Vat colours This class of colour is insoluble in water but is converted to a soluble form having affinity for cellulose by chemical reduction in the presence of alkali. The insoluble form is then regenerated in the fibre structure by oxidation.

Dye baths were prepared cold with

Vat pigment to give 1% dyeing,
2.5 g/l Solidegal GL (Hoechst)
1.25 g/l Solidegal SR (Hoechst)
6 g/l caustic soda
3 g/l sodium dithionite

After entering the yarns the temperature was slowly raised to 60°C and dyeing continued for 45 min followed by cold wash - oxidation and soaping.

In the case of Caldeon Yellow 5G - CI Vat Yellow 2 and Caledon Green XBN - CI Vat Green 1, pineapple fibre dyed dul r in shade than linen.

With Caledon Orange 3G - CI Vat ange 15 and Caledon Blue XRC - CI Vat Blue 6, pineapple fibre dyed unlevel.

C/5.4 Biocides Biocides are added to flax rove to preserve it from microbial attack while in the wet state prior to spinning. Unless subsequently removed by a scouring treatment retained biocides can sometimes affect dye uptake. A selection of proprietary products which are effective biocides on flax was examined on pineapple fibre. Hanks of wet spun pineapple yarn were treated for 20 min cold at 20:1 liquor ratio with 5% owf of the undernoted products, hydroextracted and dyed cold in identical dyebaths containing 0.1 g/l Procion Red MX5B (to which additions of 60 g/l common salt and 10 g/l soda ash were made).

Compared with an untreated control, shade variations are recorded:-

Mystox LB	Much lighter than control
Acticide SPX	As control
Dodigen 226X	Lighter than control
Resista 4102	Much lighter than control

These results are similar to those experienced on flax rove.

Section 6

CONCLUSIONS, DISCUSSIONS, AND RECOMMENDATIONS

6. Spinning

The conclusions listed in the Spinning Section (S/5) of this report indicate clearly that it is possible to process pineapple fibre using traditional flax machinery.

The flax line system may be used to process decorticated long pineapple, after some manual pre-treatment.

The flax tow system may be used to process degummed pineapple fibre after suitable pre-opening.

The advantages and disadvantages of the different raw materials and the different processing systems are discussed below.

.1 Decorticated long pineapple fibre As received in Northern Ireland, the decorticated fibre was compacted, and the individual bunches of fibre needed to be opened by hand, and required a manual pre-combing treatment to open out the tangled ends in preparation for normal hackling. It would be preferable if this manual combing treatment could be regarded as an additional part of the decortication process, to be carried out before the fibre is sent to the spinning mill. It would also be advantageous if the final wet process of decortication could incorporate a surface-active softening agent to ease subsequent dry processing.

Hackling of the prepared pineapple fibre presented no major problems; it was handled in exactly the same way as scutched flax using the same machine setting. However, the hackling process necessarily divides the raw material into two components, namely

(a) long parallel fibres ("line") and
(b) shorter, tangled fibres ("tow").

The long fibre follows the orthodox flax screwgill preparation system with no major difficulties although we found it advantageous to use a tow screwgill finisher drawing to shorten the fibre for dry spinning.

The tow fibre arising from the hackling process amount to about half of the total fibre entering the hackling machine. Tow fibre requires to be carded, doubled, combed and prepared, preferably using intersector gill-boxes, exactly as flax tow would be processed before roving.

Thus, in order to make use of all the fibre obtained from the decortication process, it would be necessary to set up not only a flax line preparing system, but also a flax tow preparing system, as outlined in Section 3-4 of the report. The same wet-spinning equipment could be used for both the longer line fibre and the shorter machine-tow fibre derived from the original decorticated pineapple fibre raw material.

.2 <u>Degummed Pineapple Fibre</u> The degummed fibre, as received, had been press-packed in a damp condition, and had been delayed in transit. On allowing the fibre to dry out naturally, it tended to adhere together in hard lumps, and initial trials on a flax finisher card were very unpromising. However, subsequent trials using a flax breaker card for initial opening, followed by a flax finisher card, were much more successful. The carded sliver processed well on an intersector gill-box for pre-comb doubling, and was combed satisfactorily using Schlumberger flax combs. The only disadvantage was a rather high combing loss of some 30%. The combed sliver could be processed alone, or blended with polyester or acrylic tops, conveniently and efficiently on an intersector system as used for flax tow. This is in fact a semi-worsted drawing system which is compact, efficient, and versatile.

.3 <u>Degummed v Decorticated</u> When 100% degummed pineapple fibre was made into rove and was wet-spun, the yarn produced was not as strong as that made from 100% decorticated long pineapple fibre, wet-spun. However, when blended 50/50 with either polyester or acrylic fibre, the yarns containing degummed piná fibre were just as strong as those containing decorticated pina, and in some cases, the degummed fibre blends could be spun to slightly finer counts. While there is clearly a requirement to produce the best possible yarn from 100% pineapple fibre, we believe that the blend yarns containing 25% or 50% polyester would have a wider market, and these blends can be made from degummed pine fibre, processed efficiently by the card-comb-intersector preparation route. Thus, we feel that the installation of a traditional line flax system of hackling and screwgill drawing, to process decorticated long pineapple fibre, is barely justified, because it would entail the installation of a parallel tow system to deal with the short fibre produced at hackling. On the other hand, if degummed pina is chosen as the starting point, a flax tow system of cards, intersector gill-boxes, and rectilinear combs could deal with all the degummed fibre as a single entity. It is possible that the flax breaker card might be replaced by a wet-opener, and there is, moreover, some potential for improving the handling properties of the degummed fibre by amending the degumming and bleaching sequence, to give a less compact mass of fibre. On balance, therefore, we would recommend that consideration be given to the purchase of carding, combing, and drawing equipment basically similar to that used for flax tow preparation by the semi-worsted system. This system produces sliver suitable for either dry spinning or roving and wet spinning.

.4 Spinning We believe that the wet-spinning process gives a smoother, finer, and more acceptable yarn than dry-spinning. Comparable counts of wet-spun and dry-spun blend yarns have been wefted across a flax warp to illustrate the differences in appearance and handle.

Wet-spinning of blends containing 25% or 50% of polyester fibre, or 50% of acrylic fibre, has not presented any major problems.

Wet-spinning of 100% pineapple fibre was also possible, but was more difficult than the blends. In the early part of the programme, it was necessary to extend the reach of the Mackie open-reach frame, and to increase roller pressure, to spin 100% pineapple fibre. It was not found possible to use the newer Linmack frame for 100% pina. In some recent work, carried out after the official termination of the project, it has been found advantageous to add a surface active agent to the spinning trough, when spinning bleached rove made from 100% pineapple fibre spun on the Mackie open reach frame. Further work in this area would be advisable, to explore the various spinning options.

6.2 Chemical Treatments

It was clear from initial observations of the stricks of pineapple (as received in the decorticated and washed state) that there were three problems to be addressed:-

(i) Ensuring that the material was presented in a satisfactory (unmatted) physical state for processing into rove and yarn.

(ii) Attaining a uniform and acceptable degree of whiteness of the fibre with good light fastness.

(iii) Destruction/removal of adhering tissue.

This section examines the extent to which these problems were resolved in the limited time allowed by the project.

(i) Physical state Wet treatments involving alkali generally promote fibre entanglement while those on the acid side and those where softening agents are applied, improve the condition of the fibre. The use of dilute acid and/or a softener immediately after decortication is felt to be of value in this respect and should be further investigated by PTRI.

(ii) Bleaching Of the various agents examined, hydrogen peroxide proved best although the bleached shade had limited stability to light. This would affect the production of high whites and pastel dyed shades.

(iii) Adhering Tissue Wet processes had a minor effect upon the associated non fibrous matter. It is to be anticipated that hackling or carding and combing would contribute to reducing this problem.

These considerations suggest possible processing sequences in broad outline.

Decortication

Acid treatment eg 5 ml/l HCl	Wash off and apply softener
Wash off	Hydroextract
Peroxide bleach as in C/3.2	Dry
Apply softener	Hackle
Hydroextract	Prepare rove
Dry	Boil
Card	Peroxide Bleach
Comb	
Prepare	
Dry Spin from sliver / Rove → Wet Spin	Wet spin through lubricant

6.2.1 Possible further work From the experience gained in the limited duration of this study it is evident that, while appreciable progress was made in the production of yarns from pineapple fibre; further work, much of a fundamental nature is required before secure processing routines can be established. Attention needs therefore to be paid to the undernoted aspects:-

1. The initial wetting of the fibre after mechanical decortication is seen as crucial to subsequent operations. Identification of the precise chemical nature of the substances which bind the fibre to adjacent tissues in the plant leaf would be a necessary preliminary to freeing the fibre of such impurities.

2. The factors which govern fibre bundle subdivision and fibre/fibre adhesion in dry and wet states require closer study if roving and spinning operations are to be optimised.

3. The presence of lignin appears to have a deleterious effect upon the fastness of pineapple fibre on exposure to light. Means of removal, reduction or masking of its effect should be sought, which will not markedly affect fibre strength and durability.

4. Information on comparative fastness of dyes on pineapple fibre and on other cellulosic fibre when subjected to the effects of various agencies, needs to be ascertained in fitting the fibre for different end-uses.

5. Small quantities of adhering tissue are associated with the fibre. These affect the quality of yarns and the appearance of fabric both in the natural and dyed states. Degradation and removal of tissue without altering fibre properties is essential and a study of techniques to achieve this objective needs to be undertaken.

APPENDIX I - PHYSICAL PROPERTIES OF YARN SAMPLES

Sample No	Fibre Composition	Spinning Method	Nm	Tex	Strength g	Tenacity g/tex
1	100% Degummed Pina, Combed	Wet	12	82	540	6.6
2	100% Decorticated Pina, Line	Wet	18	55	455	8.3
3	100% Decorticated Pina, Line	Wet	18	55	475	8.6
4	100% Decorticated Pina, Machine tow	Wet	15	65	577	8.9
5	100% Decorticated Pina, Machine tow	Dry	12	82	591	7.2
6	100% Decorticated Pina, Machine tow	Dry	15	65	397	5.95
7	100% Degummed Pina, Combed	Dry	12	82	-	-
8	50/50 Pina Machine Tow/Polyester	Wet	17	59	349	5.9
9	50/50 Degummed Pina/Polyester	Wet	25	40	540	13.9
10	50/50 Degummed Pina/Polyester	Wet	36	28	318	11.5
11	50/50 Decorticated Pina/Polyester	Wet	21	48	655	13.6
12	50/50 Decorticated Pina/Polyester	Wet	25	40	-	-

APPENDIX 1 CONTINUED

Sample No	Fibre Composition	Spinning Method	Nm	Tex	Strength g	Tenacity g/tex
13	50/50 Decorticated Pina/Polyester	Wet	35	28	302	10.8
14	50/50 Decorticated Pina/Polyester	Wet	29	35	405	11.6
15	50/50 Decorticated Pina/Polyester	Wet	24	41	547	13.3
16	50/50 Pina Machine Tow/Polyester	Wet	30.5	33	400	12.1
17	50/50 Pina Machine Tow/Polyester	Wet	40	25	411	16.0
18	50/50 Degummed Pina/Acrylic	Dry	12	82	431	5.2
19	50/50 Degummed Pina/Acrylic	Wet	33	30	281	9.3
20	50/50 Decorticated Pina/Acrylic	Dry	9	105	591	5.6
21	50/50 Degummed Pina/Acrylic	Wet Linmack	34	31	258	8.3
22	50/50 Degummed Pina/Acrylic	Wet Linmack	30	33	423	12.8
23	50/50 Degummed Pina/Acrylic	Wet Linmack	30	33	321	9.7

APPENDIX 1 CONTINUED

Sample No	Fibre Composition	Spinning Method	Nm	Tex	Strength g	Tenacity g/tex
24	50/50 Decorticated Pina Line/Acrylic	Wet	14	70	579	8.3
25	50/50 Degummed Pina/Acrylic	Wet	36	28	262	9.3
26	50/50 Pina Machine Tow/Acrylic	Linmack Wet	22	45	514	11.4
27	50/50 Decorticated Pina Line/Acrylic	Dry	15	67	483	7.2
28	50/50 Decorticated Pina Line/Acrylic	Wet	23	44	373	8.5
29	50/50 Decorticated Pina Line/Acrylic	Wet	18	55	507	9.2
30	50/50 Decorticated Pina Line/Acrylic (Softened)	Wet	15	67	607	9.0
31	50/50 Decorticated Pina Line/Acrylic	Wet	19	52	462	9.8
32	50/50 Decorticated Pina Line/Acrylic (Softened)	Wet	26	39	300	7.7
33	50/50 Degummed Pina/Acrylic	Wet	26	39	372	9.5
34	50/50 Decorticated Pina Line/Viscose	Wet	14	72	562	7.8

APPENDIX II

ROVE TREATMENT OF PINEAPPLE FIBRE

Decorticated Pineapple fibre may be chemically treated or bleached in the form of rove, prior to wet spinning. The following points need to be observed in the preparation of the rove, and in subsequent wet treatments.

(1) Rove twist should be calculated on the basis of

$$\text{turns/inch} = 0.09\sqrt{\text{yards/oz}}$$

ie a rove which is 100 yards/oz in the dry state would have a twist of approx 0.9 tpi.

The Equivalent Metric Relationship is
$$\text{turns/metre} = 624/\sqrt{\text{tex}}$$

(2) The rove bobbins used are normally moulded from polypropylene, and are designed to stack six or seven high, in a bleaching vessel similar to those used for package bleaching or dyeing of yarn. The rove bobbins have perforated barrels to allow circulation of liquor. Bobbins with different perforations should not be mixed in the same bleach bath.

(3) The build and density of the rove on the bobbin must be uniform throughout the bobbin, from bobbin-to-bobbin within a doff, and from doff to doff. The rove must cover the full length of the bobbin barrel, but should not have hard ends at top or bottom. The traverse wheel and index wheel should be chosen to give a dry rove density on the bobbin of 0.35 $\pm$ 0.02 g/cc, to allow free circulation of liquor during boiling and/or bleaching.

(4) A number of alternative chemical treatments may be applied to 100% decorticated pina rove, or to blends with polyester fibre. Typical recipes are given in Part C.

APPENDIX III

The following companies manufacture machinery for the processing of flax.

Hackling Machines

(1) James Mackie & Sons Ltd
P O Box 149
BELFAST
BT12 7ED
Northern Ireland

(Now part of the Lummus Group)

(2) Bolelli Fratelli, Milan

(Now operating as part of the Italian flax spinning group, LINOFICIO NACIONAL)

Carding Machinery

(1) James Mackie & Sons Ltd

(2) HDB
Houget Duesberg Bosson SA
37 rue de Tissage
Ensival, Belgium

(3) Gardella Impianti Sistemi Industriali Spa
via F.lli Canepa CP 1595
16010 Serra Ricco
16100 Genova
ITALY

Screwgill Drawings, Flax Roving Frames

(1) Mackie, Northern Ireland

(2) Bolelli, Italy

(3) Gardella

Rectiliner Combs

(1) Mackie, Northern Ireland

(2) NSC

N Schlumberger Et CIE
170, rue de la Republique
68500
Guebwiller
France

Intersector Gill Boxes

(1) Schlumberger, France

(2) Mackie, Northern Ireland

Wet Spinning Frames

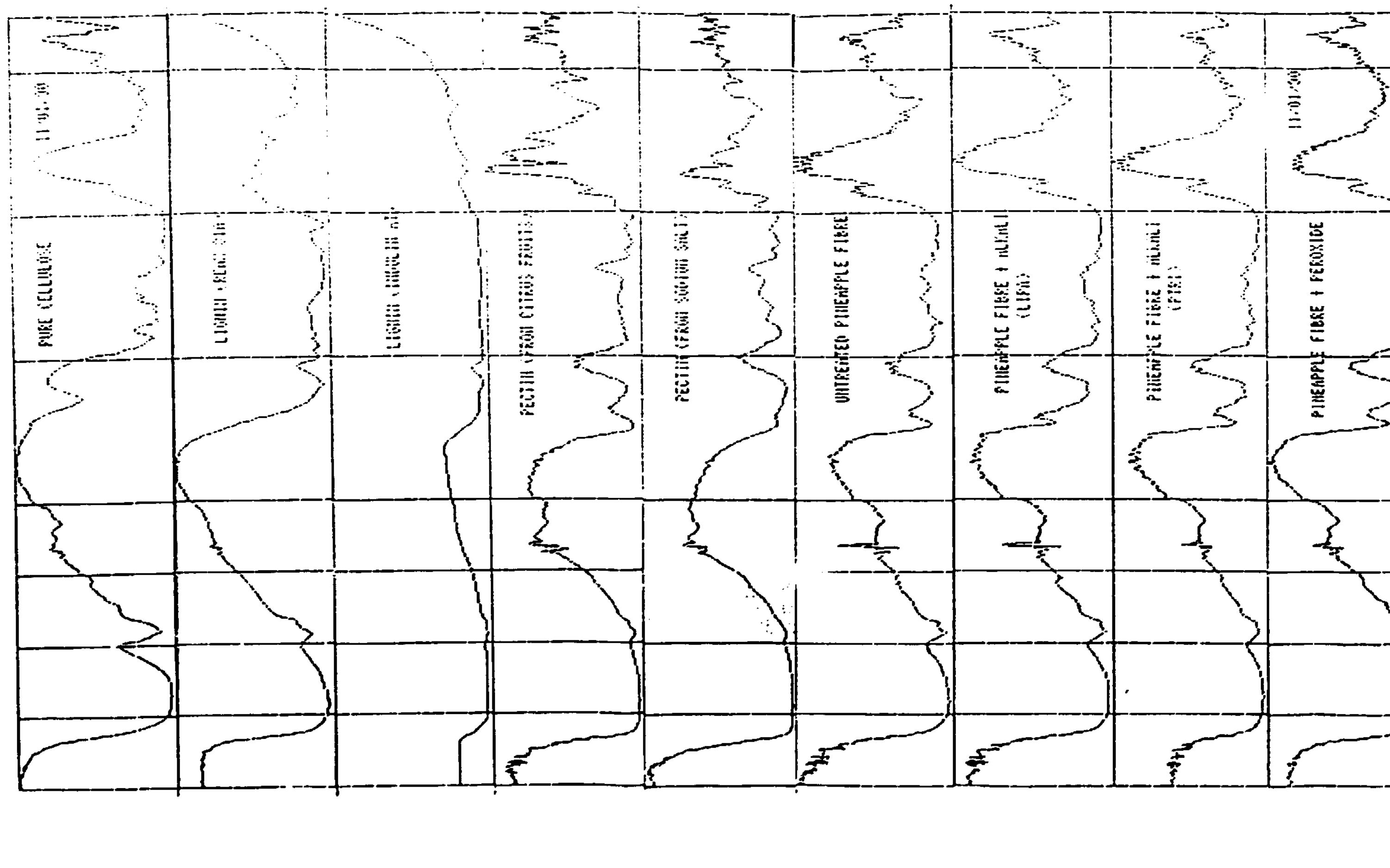
(1) Mackie, Northern Ireland

(2) M.A.B. - Alsace, France

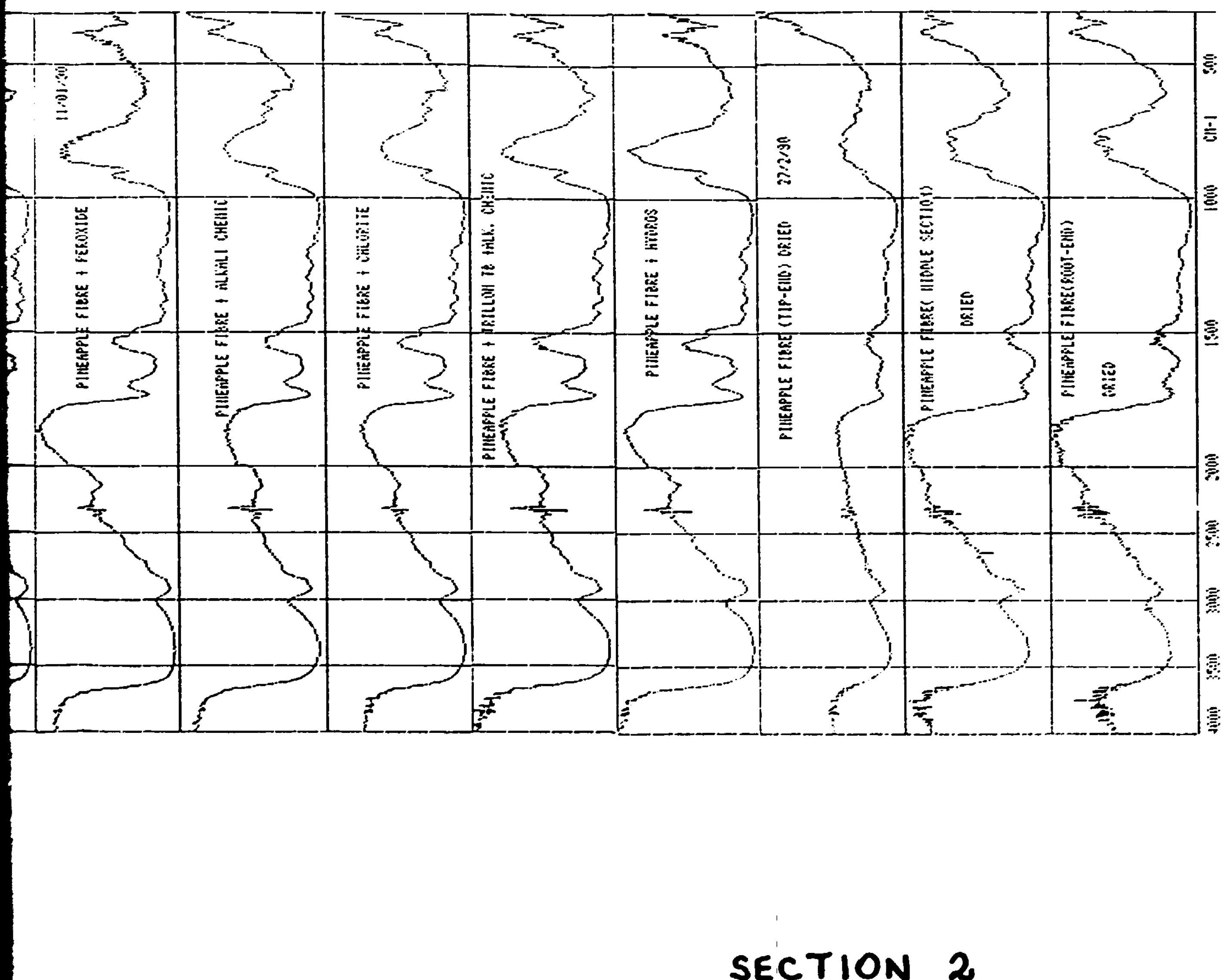
(3) Bolelli, Italy

APPENDIX 4

INFRA RED SPECTRA OF VARIOUS SPECIES


PURE CELLULOSE
PECTIN (FROM CITRUS FRUITS)
UNTREATED PINEAPPLE FIBRE
PINEAPPLE FIBRE + PEROXIDE

SECTION 1


11/01/90
PINEAPPLE FIBRE + PEROXIDE
PINEAPPLE FIBRE + ALKALI CHEMIC
PINEAPPLE FIBRE + CHLORITE
PINEAPPLE FIBRE + TRILLON TB +ALK. CHEMIC
PINEAPPLE FIBRE + HYDROS
27/2/90
PINEAPPLE FIBRE (TIP-END) DRIED
PINEAPPLE FIBRE(MIDDLE SECTION)
DRIED
PINEAPPLE FIBRE(ROOT-END)
DRIED
500
CM-1
1000
1500
2000
2500
3000
3500
4000

SECTION 2

APPENDIX 5

Lignin removal from flax

(a) 30 g/l sodium sulphite at boil for 30 min.

(b) Treat in alkaline hypochlorite (7 g/l available chlorine) at 30:1 liquor-to-goods ratio for 10 min cold.

(c) As (a) for 20 mins.

(d) As (b).

(e) As (a) for 10 mins.

(f) Treat in hypochlorite (1.5 g/l available chlorine) containing 8 ml/sulphuric acid for 10 mins cold.

(g) As (e).

Repeat (f) and (g) until there is no further colour on the material from sulphite.

REFERENCES

1. LIRA Private Memo 579 (April 1990) to UNIDO

   Pretreatments of Pineapple Fibre
   W B Shannon

2. LIRA Private Memo 580 (April 1990) to UNIDO

   Preparation and Spinning of Pineapple Fibre
   A G Rankin and R Colwell

ACKNOWLEDGEMENTS

Four members of the Philippine Textile Research Institute (Directoı Dr E Villanueva) were involved in the preparing and spinning trials: Mr Marin and Mr Ramirez (January and February 1990), and Mrs Mangalinden and Mrs Pedrugao (March and April). Two others, Miss Geronimo and Miss Tayag were involved in the chemical treatment trials (January and February 1990). They all made valuable contributions to the project by discussions, and participation in the practical work.

The work of Mr John Reilly (LIRA) on Chemical Tratments must also be included and acknowledged.