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INDIGENOUS FIBRES - DEVELOPMENT OF THEIR PROCESSING TECHNOLOGY AND USE IN TEXTILES - PHASE I

SI/PHI/87/002/11-01

PHILIPPINES

Technical report: Pre-treatment of indigenous fibres for textile processing*

Prepared for the Government of the Philippines
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of P.C. Das Gupta
Expert in fibre pre-treatment

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United Nations Industrial Development Organization
Vienna

* This document has not been edited.

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MISSION SUMMARY

The consultant was at the Philippin Textile Reaserch Institute (PTRI) from 27th January to 21st February, 1989, and the results of the mission are summarized below :

(1) The consultant had detailed discussion with the scientists of the R & D division of PTRI about the morphology, constituents, physical characteristics and approach to chemical pretreatment of multicellular fibres.

(2) The consultant had reviewed the PTRI work on indigenous fibres and studied the raw fibres as well as fibres pretreated with PTRI-developed methodology.

(3) The consultant observed the facilities available at PTRI for pretreatment, testing and processing of the fibres and recommended for providing certain equipments and machinery at PTRI to facilitate its R & D work.

(4) Some chemical pretreatment experiments were conducted on pineapple, kenaf and banana fibres and the fibre samples compared with PTRI pretreated samples.

(5) Pretreatment experiments for the fibres were designed for PTRI to pursue as its long-term programme of work. Fibre characteristics related to spinning as well as its gum content will be studied for the assessment of the treated fibres.

(6) PTRI will prepare bulk samples of pineapple, kenaf and banana fibres based on its developed methodology for spinning trials in worsted system at Leeds University and in flax system at LIRA. The feed back informations from the spinning trials will be helpful in formulating the future pretreatment experiments.

(7) The consultant visited Ramie Textiles, Inc. and the National Institute of Biotechnology and Applied Microbiology at Manila for observing degumming and processing of ramie. The consultant also visited abaca and pineapple plantations and extraction sites at Davao and Bukidnon.

INTRODUCTION

The purpose of the mission was to review the activities and facilities available at PTRI for R & D work on pretreatment of indigenous fibres for textile purposes and to guide PTRI in its continuous research work.

The programme of activities of the consultant is given in Annexure I. In the beginning the consultant held a briefing in Vienna with Mr. Antero Eraneva who provided an outline of the objective of the mission and background information of the work so far done at PTRI.

The Philippines produces several indigenous fibres isolated from the stem, leaf or pseudo-stem of different plants and some of which are derived from fruit plantation wastes. On the other hand, cotton production in the Philippines is small compared to its need for producing textile materials. In the present mission five fibres namely, pineapple, kenaf, banana, abaca and maguey were studied for their textile potentiality. The production, price and some other informations about the fibres are tabled in Annexure II.

The immediate requirement is to prepare bulk amount of pretreated fibre samples for spinning trials at some selected centres. The long-term objective of the project will be to improve upon the quality of the fibres by developing suitable pre-treatment methods.

This report depicts the problem of pre-treatment of hard fibres, the activities of the consultant during the mission, proposal for future work and recommendations for providing certain equipments to the Institute to facilitate the work on pre-treatment and assessment of pre-treated fibres in spinning.

LONG VEGETABLE FIBRES AND THEIR TREATMENTS FOR TEXTILE PROCESSING

Pineapple, kenaf, banana, abaca and maguey are all multicellular fibres whereas ramie is a unicellular fibre. The materials associated with the cellulosic components of ramie are incrustation and need to be removed more or less completely before its textile processing. But in the case of the above mentioned fibres, the non-cellulosic materials are mostly cell components. Too much removal of cell components by degumming process will lead to pulp and due to the shorter length of the ultimate cell, the treated material may not be suitable for textile processing. The aim for chemical pretreatment shall be to separate the fibres by removal of interfibre cementing meterial and to remove the optimum amount of cell material to make the fibres suitable for textile processing.

The fibres under study are coarse, hard, stiff and lack inter-fibre cohesion. The physical characteristics and chemical constituents of the fibres are given in Annexure III. The fibres need to be treated by mechanical or chemical or microbial process and/or a combination of processes to make the fibres finer, softer, supple and with improved surface property without impairing the strength very much so that the fibres can be processed either in pure form or in blends with other textile fibres in textile processing system to produce valued textile materials.

The Philippine Textile Research Institute has established specific pretreatment conditions for each of the fibres and also processed the pretreated fibres in cotton and worsted processing systems to produce yarns in blends with synthetic fibres. The results of the initial trials indicated for improvement in the pretreatment processes to produce yarns of better quality and uniformity.

PLAN OF R & D WORK AT PTRI ON PRETREATMENT OF INDIGENOUS FIBRES AND TESTING OF TREATED FIBRES

1. Fibre samples and Pre-treatment of Fibres

(a) In order to have the raw fibre of comparable quality for various pretreatment experiments and for comparison of the results, the fibre should be collected from one or more similar lots after proper sampling.

(b) The R & D division of PTRI, based on its work on degumming of ramie, aimed at the removal of non-cellulosic materials, as far as possible, from the indigenous fibres under study to make the fibres suitable for textile processing. Efficacy of this pretreatment was studied in terms of gum content, strength and finness of the fibres. In some instances the action was drastic and too much removal of cell material lead to pulping. In the case of fibres under study which are multicellular, the aim should be to improve upon the fibre properties for spinning, keeping as much of the non-cellulosic cell material as possible and optimum conditions have to be worked out for each of the fibres.

(c) Enzymatic treatment with specific enzyme such as pectinase, hemicellulase and ligninase may be tried for initial softening of fibres.

(d) Fibre samples after chemical or enzymic pretreatment should be treated with oil-water emulsion or suitable surfactant (mostly cationic type) solution, followed by ageing and mechanical softening to make the fibres supple.

(e) The hemicellulose (gum) material of pineapple fibre was easily extracted by dilute alkali solution in the cold and the viscous solution adhered to the fibre and made the fibre sticky. Milder alkali treatment of pineapple fibre will not be suitable.

(f) Pineapple fibre was found to be softer on soaking in water for two days. Water-soaked pineapple fibre may be processed as flax fibre.

(g) In the case of kenaf and banana fibres woollenization as well as boiling with suitable concentration of alkali may be tried.

(h) Treatment with sodium sulphite at about 160° C may be tried for softening kenaf, banana, abaca and maguey fibres (Dr. K. V. Sarkanen mentioned in his report on Jute Products Research about treatment with $Na_2 SO_3$).

(i) Abaca and maguey fibres, after initial treatment with Na_2SO_3, may require further treatment with caustic soda solution at boil.

(j) Some pretreatment experiments were conducted on different fibres. As no definite results were obtained during the short term of the mission, it was decided that PTRI will prepare bulk samples of pineapple, banana and kenaf fibres based on its developed methodology for spinning trials at Leeds University and LIRA.

2. **Testing of Treated fibres**

The R & D division of PTRI testes the treated fibre samples for gum content, tensile strength and fineness which certainly give valuable informations about the quality of the fibre and their suitability for textile processing. The fibres should also be tested for suppleness, inter-fibre cohesion and combing loss which are also correlated with the spinning performance of the fibres. But the final testing should be through spinning trials.

The Institute should have a miniature spinning unit, preferably worsted system, for spinning trials on the treated samples and for establishing optimum spinning conditions.

RECOMMENDATIONS

1. Equipment and Machinery

PTRI will need the following equipments and mechinery for its R & D work on indigenous fibres :

(a) one 12-15 litre capacity temperature/pressure controlled revolving type digester
(b) equipments for testing

  (i) suppleness of the fibre
  (ii) inter-fiber cohesion
  (iii) combing loss - sets of small combing system with different pin size and density. This has to be made locally. The consultant will try to prepare a set in Calcutta and deliver the same to PTRI in future.

(c) Miniature worsted spinning system suitable for processing about one kilogram of fibre.
(d) One small size stainless steel hydroextractor.
(e) One small Wiley mill

2. Pretreatment of fibres

In case of multi-cellular fibres, the aim of pretreatment should be for the attainment of improved fibre properties for spinning, keeping noncellulosic matter (gum) as much as possible.

3. Microbial Softening of fibres

Microbial softenting of fibres should be tried in conjunction with other pre-treatment methods using hemicellulase, pectinase, ligninase and other specific enzymes or organisms which produce the enzymes. The R & D division may develop the methodology with the initial help from a microbiologist/biochemist.

4. Grading of fibres

The fibres received at PTRI from different sources were of variable qualities. For developing pre-treatment methodology it is necessary to have standard raw material to work with. Some sort of grading of fibres will be helpful in that respect.

5. Traineeship

One or two senior researchers from P.T.R.I. may be sent to Indian Jute Industries' Research Association at Calcutta for training in testing and processing; to Jute Technological Research Laboratory, Indian Council of Agricultural Research, Calcutta, for training in chemical and microbial treatment of fibres and to Textile Technology Department, Indian Institute of Technology, Delhi, for training in textile processing and modification.

ANNEXURE - I

PROGRAMME OF ACTIVITIES OF P. C. DASGUPTA
UNDP/UNIDO PROJECT DP/PHI/87/002

1.	Departure Calcutta	January 22, 1989
2.	Arrival at Vienna	January 23, 1989
3.	Briefing at Vienna	January 24, 1989
4.	Departure Vienna	January 25, 1989
5.	Arrival at the NAIA	January 26, 1989
6.	Orientation/PTRI Tour	January 27, 1989
7.	Visit to UNDP/FIDA Attendance to ASEAN S & T Week Opening	January 30, 1989
8.	Lecture/Discussion/Experimentation on Fibre Pretreatment	January 31 - February 8, 1989
9.	Field/Plant Visits	
	a) Ramie Textiles, Inc. Valenzuela, Metro Manila - integrated textile mill for ramie fabric production	February 9, 1989 (a.m.)
	PTRI - evaluation of fibres treated with suggested pretreatment conditions	(p.m.)
	b) National Institute of Biotechnology and Applied Microbiology (Biotech), UPLB, Los Banos, Laguna - enzymatic degumming of ramie fibres	February 10, 1989 (a.m.)
	PTRI - evaluation of the carding performance of treated fibres	(p.m.)
	c) Davao, General Santos City and Bukidnon via Cagayan de Oro - abaca and pineapple plantation and extraction sites	February 14-17, 1989
10.	Evaluation of Results of Experimentation Report Preparation/Recommendation	February 13 & 20, 1989
11.	Departure from the NAIA	February 21, 1989
12.	Arrival at Calcutta	February 25, 1989

ANNEXURE – II

PRODUCTION AND PRICE OF SOME PHILIPPINE NATURAL FIBRES FOR TEXTILES[a]

NAME OF FIBRES	PINEAPPLE	BANANA	KENAF	ABACA	MAGUEY
BOTANICAL NAME	Ananas Comosus (Smooth Cayenne Variety)	Musa Sapientum Linn (Cavendish Variety)	Hibiscus Cannabinus Linn	Musa Textiles Nee	Agave Cantala Roxb
METHOD OF EXTRACTION	Decortication	Decortication	Retting	Spindle	Retting in Sea Water
FIBRE RECOVERY (%)	2.0	2.0	4.5	2.3	1.5
VOLUME OF PRODUCTION (tons)	61.15 IN 1988	99567 in 1986	228.1 in 1987 232.7 in 1988	43690 in 1987 44959 in 1988	416.18 in 1987 515.1 in 1988
TRADERS BUYING PRICE P/kg	$387.50/bale P/66/kg	–	6.30 – 8.10	7.90 in 1987 11.91 in 1988	3.50 in 1987 5-6.8 in 1988

(a) Planning and Statistics Division,
Fibre Industry Development Authority,
Philippines.

ANNEXURE III

PHYSICAL CHARACTERISTICS AND CHEMICAL CONSTITUENTS OF PHILIPPINE NATURAL FIBRES FOR TEXTILES[a]

NAME OF FIBRES	PINEAPPLE	KENAF	BANANA	ABACA	MAGUEY
Ultimate Cell Length, Ave., mm	5	2.5	3.5	3	5.6
Ultimate Cell Diam. mmx 10^{-3}	8	23	25	20	–
Tensile Strength, Raw	17.14	15.6	20.9	40.8	16.4
(Kg-m/g) Treated	22.1	-	21.6	28.6	22.5
Fineness, Raw	13.4	41.2	48.8	98.5	121.0
(denier) Treated	7.8	28.1	34.4	52.2	87.1
Moisture Content, (%)	9.5	9.8	9.7	10.8	11.9
Alcohol-benzene Extractive (%)	3.0	0.4	1.7	1.7	4.7
Loss on water boil (%)	2.6	–	13.1	–	17.8
Loss on 1% alkali boil (%)	19.5	2.2	28.6	18.4	–
Total Cellulose[b] (%)	75.2	77.0	81.8	68.5	64.0
Alpha-cellulose (%)	57.2	58.2	61.5	54.5	59.2
Lignin (%)	5.0	8.6	15.0	8.7	5.1
Ash (%)	0.9	0.4	4.8	1.3	2.0
Residual gum, Raw	31.7	26.6	41.9	28.7	33.2
(%) Treated	7.4	7.1	8.1	6.4	7.0
Treatment	5% NaOH, 1 hour at boil	8% NaOH, 2 hrs. at boil	18% NaOH, 2 Hrs. at room temp. 6% NaOH, 2 hrs. at boil	18% NaOH, 2 hrs. at room temp. 5% NaOH, 1 hour at boil	0.1% Na_2S, 115°C for one hour 8% NaOH for 2 hours at boil

(a) Analytical data from Philippine Textile Research Institute
(b) Using 2% Na_2SO_3 in boil for 10 minutes, NaOCl (10% available chlorine) at acid pH for 10 minutes (Modified Japanese Method)