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18342

DP/ID/SER.A/1338/Rev. 1
10 September 1990
ORIGINAL: ENGLISH

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

DP/PHI/87/002/11-01

PHILIPPINES

Technical report: Second mission*

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

Based on the work of P.C. Das Gupta
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Vienna

* This document has not been edited.

V.90-87603

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LONG VEGETABLE FIBRES AND THERE TREATMENTS FOR TEXTILE PROCESSING

The fibres isolated from stem (bast), leaf and pseudo-stem of plants such as pineapple, kenaf, banana, maguey and abaca fibres unlike ramie fibre, are lignocellulosic and muticellular in nature. The morphology of the above fibres also differ amongst themsleves. The main constitutents of the fibres are cellulose, lignin and hemicellulose (gum) and the disposition and quantity of lignin and hemicellulose in the cell are somewhat different for different fibres. As such the response of the constituent on chemical pretreatment of the fibres for their dissolution, removal or modification are different. The chemical pretreatment also affects the morphology or fibrous nature of the fibres differently. The hemicellulose in pineapple fibre can be removed comparatively easily by alkali, which form a viscous solution in alkali and if not removed properly by washing sticks the fibres forming a stiff bundle. Whereas hemicellulose in kenaf can be removed with alkali without having much sticking property. Kenaf, maguey and abaca withstand treatment with dilute alkali at higher temperature better than pineapple or banana fibres.

The above mentioned long vegetable fibres are coarse, stiff and brittle fibres. The fibres have good strength but low extension.

If the fibres are extracted from the plant materials by decortication and are not exposed to any microbial treatment, pectin or other cementing materials present in the plant will remain in the fibre and may cause the fibres to remain as joint fibres.

The ultimate cell of the above-mentioned fibres are within the range of 2.5 - 6 mm and are too short for processing in textile processing system to produce yarn. Any treatment of the fibre intended to make them suitable for textile processing should not be drastic to cottonise the fibre and expose the ultimate cells. The short fibres even if they are processed in blends with other fibres may produce waste and, cause difficulty in spinning and produce uneven yarn.

As the fibres are coarse, they produce coarse yarn if processed without any pre-treatment or processed alone. Chemical or microbial treatment is necessary for fibre separation and to produce finer fibre.

The fibres are brittle, succeptible to breakage and produce short fibre during carding. Improvement in pliability by mechanical or chemical treatment will certainly improve textile processing and produce yarn of better quality.

So it is necessary for chemical pretreatment of the above mentioned fibres for the improvement of their fineness, suppleness and also cohesiveness to make them amenable to textile processing and to produce suitable yarn for making into textile materials. In the process of chemical pretreatment some amount of cell materials will be removed. Too much removal of cell material will increase the price of the treated fibre, impairing the economy of the process and at the same time may lead to cottonisation in certain fibres. Only that amount of cell materials has to be removed that are necessary for the improvement of the physial characteristics of the fibre for textile processing.

INTRODUCTION

The consultant was with the Philippine Textile Research Institute in the first month of his assignment from 27th January to 21st February 1989 and presented the technical report, DP/ID/SER.A/1182 dated 5th March 1989 about the mission work for that period.

PTRI prepared samples of indigenous fibres according to its earlier developed methods of treatment and the samples were sent to Leads and LIRA for processing trials. The Consultant shall study the report of processing trials which may help in the planning of the future work.

In the earlier mission, the Consultant recommended a plan of work about pretreatment of indigenous fibres. PTRI, in the meantime, had done some experiments according to the plan. The Consultant shall review the pretreatment activities and recommend the future programme of work.

The Consultant brought with him two sets of small combing system for work at PTRI.

The Programme of activities of the Consultant is given in Annexure I

MISSION SUMMARY

The Consultant during his second term of assignment was at PTRI from 29th January to 23rd February 1990 and the results of the mission are summarized below:

(1) The consultant reviewed the Interim report on the processing and use of indigenous fibres at Leeds by Dr.W. Oxenham and Dr. P.A. Smith.

(2) The consultant reviewed the work done at PTRI according to the plan of work as mentioned in the First Report.

(3) Some experiments on pretreatment of kenaf, pineapple, and banana fibres were done to make the fibres suitable for processing.

(4) Spinning trials were done with pretreated kenaf and pineapple fibres blended with polyester in the cotton system.

(5) The consultant visited the M/s Dymac in Quezon City to observe the operation of their fibre extraction machine. The consultant also visited Indo-Phil Textile Mill, Maguey plantation at La Union and Sericulture station at Baguio.

(6) The indigenous fibres of Philippines namely, pineapple, kenaf, banana, maguey & abaca were treated with solutions of sodium hexametaphosphate, sodium sulphite, sodium sulphide and sodium hydroxide either alone or in sequence at various reaction conditions to improve upon the fibres separation, softness, fineness & suppleness so as to make the fibres suitable for textile processing. Considering the nature of the fibres, they can be pretreated maintaining their fibrous nature only to a stage of improvement at which they have to be considered for processing to textile materials. The pretreatment experiments produced fibres which could be made into yarns when belended with finer varieties of man-made fibres & processed in a suitable textile processing system. It was recommended that the pretreated fibres should be processed to make suitable textile material in a modest way. The materials should then be marketed to obtain consumers' reaction. The process technology can then be modified wherever necessary for the improvement of the products.

REVIEW OF SPINNING TRIAL AT LEEDS

Dr. W. Oxenham and Dr. P. A. Smith reported about the preliminary trials on indigenous fibres of Philippine. They conducted trials on fibres pretreated with PTRI methods as well as raw fibres on small lots in order to determine the optimum conditions for spinning in bulk quantity. The fibres due to low breaking extension is susceptible to break during processing. The long fibre reeds were treated in rag pulling machine or fearnaught or stapled by hand to make the fibre length suitable for worsted processing. The former two treatments led to higher proportion of shorter fibres. The presence of shorter fibres increase card droppings and also lead to irregular yarn. In that respect a stapling machine which can produce more uniform fibre will be helpful.

The fibres both pretreated and raw showed difficulty in carding and the carding parametres were adjusted for processing the fibres. The lack of cohesiveness of the fibres also created difficulty in processing.

Certain points became evident from the initial trial about processing and the quality of yarn that can be produced

1) Only coarse yarn can be produced from raw fibre
2) fibre blended with some other textile fibres helped in processing and producing finer yarn
3) use of finer textile fibres for blending helped in producing finer yarn. In the case of pineapple fibre yarn of 20 tex can be spun using 3.3. dtex acrylic fibre in 50.50 proportion.
4) roving of the sliver before spinning produced finer yarn.

Ring spinning produces hairiness in the yarn. Yarn produced from blend with man made fibre or cotton and indigenous fibres will also have protruted fibres or hairiness.

It will not be out of place to mention here, for information, about the work done inIndia to use Jute for making textile material other than usual packaging material.

In the laboratory of the consultant's Institute stapled Jute (2.0 tex) was blended with cotton, 75 : 25 and processed in the miniature cotton card and drawing frame and then spun in an openend spinning system to produce yarn of 56 tex. The yarn was very uniform and with very little hairiness. Fabric of suiting quality was prepared with cotton yarn as warp and Jute cotton yarn as weft in which presence of Jute was masked. Jute & cotton in the proportion of 50 : 50 was processed in the miniature cotton card, drawing frame, the sliver was then roved and spun in a ring frame to 26 tex.

Long vegetable fibres of finer varieties in the raw form can be spun to finer yarn suitable for apparel textile material if blended with proper proportion of finer textile fibre and processed in proper sequence of suitable textile system.

Jute after initial treatment with oil-water emulsion was spun to yarn of 110 tex in the jute system. The jute yarn was hairy. Union fabric was made with jute yarn as warp and cotton yarn as weft. The fibres were then surface bleached at lower pH which removed the protruded fibres. The fabric was then dyed or printed to make attractive upholstery or furnishing materials. Jute polypropylene blended yarn also showed promise for certain end uses.

It is being emphasised that the results of processing of long vegetable fibres indicated that the fibres either raw or pretreated could be made into useful textile materials depending upon the fibre characteristics if proper processing technology and finishing methods are adopted.

Though raw fibre of finer quality could be used in certain instances to produce useful textile products, pretreatment of the fibres will certainly improve upon their processability and produce yarn of better quality.

VISIT TO DYMAC FIBRE EXTRACTION PLANT

The Consultant along with a scientist of the Research and Development Division of PTRI visited the M/s Dymac and Co. to observe the method of extraction of fibre in its multifibre extraction machine.

Actual feature of the machine was not shown but the consultant observed the extraction of a number of plant fibres. Extraction of fibre was slow, less fibre was extracted from the plant but the quality of the fibres extracted were better than fibres obtained from the usual decorticating machine.

Though the quality of the fibre produced by Dymac machine was good, the price of the fibre was high.

The production of good quality fibre economically using some fibre extraction system similar to Dymac may be explored.

EXPERIMENTAL WORK

Philippine Textile Research Institute had developed methods of pretreatment of pineapple, kenaf, bananas, Maguey & abace fibres in which the fibres were treated with a higher concentration of NaOH at boil (vide Annexure III First Report) and 80.7% (banana) to 73.3% (Kenaf) of gum content of the fibres were removed. The treated fibres were then given trials for textile processing in worsted/wollen system at Leeds and flax system at LIRA to produce suitable yarn. In the present Mission use of lower concentration of alkali specially at higher temperature and also solution of other chemicals having lower pH such as sodium hexametaphosphate (pH of 1% solution 6.05) & sodium suphite (pH of 1% solution 9.85) were tried. PTRI used sodium sulphide in the case of maguey fibre. 1% solution of sodium sulphide has a pH of 12.25 and was not found suitable for the treatment of pine apple fibre due to its high alkalinity. Treatment with Sodium sulphide solution will be helpful in certain cases as it will dissolve hemicellulose from the fibre cell wall and also affect the lignin which may reduce fibre rigidity. But it has to be considered that removal of major portion of lignin will disrupt the cell structure and reduce the strength of the fibre.

A number of pretreatment experiments were done by PTRI according to the plan of work recommended by the Consultant in his earlier mission and also some pretreatment experiments were done on pineapple, kenaf & banana fibre in the present mission. Only those treatments which produced soft, supple and separated fibres were mentioned.

Procedure for treatment :

The fibre received was cut to size (50 cm and above) suitable for proper handling in the reaction vessel. The fibres were made into bundles and tied loosely in the middle. This helped to prevent entanglement of fibre during washing and to produce more uniform fibre on stapling, if needed for textile processing. The fibres should remain immersed in the reacting solution during treatment. The fibres were thoroughly washed after chemical treatment (larger quantity of fibres are preferably washed in a stainless steel hydro extractor). The fibres were then treated with a solution of cationic surfactant. The fibres were squeezed or hydroextracted and dried. Treatment with cationic softener help to keep the fibres soft and well separated.

Treatment :

PINEAPPLE FIBRE

(a) The fibre was soaked in water containing 0.05% of a wetting agent for 2 days.

REMARK : The fibres appeared soft.

(b) The fibre was treated with enzyime solution such as TV cellulase and viscozyme for about one hour.

REMARK : Fibre separation was better

(c) The Fibre was treated with 1.5% ammonium oxalata solution (1 : 20) at 80° to 85° C. for 1.5 hour and then with 1% ammonium oxalate solution at the same conditions.

REMARK : The fibre were softer

(d) The ammonium oxalate treated fibre was treated with 1% sodium sulphite solution at 120°C for 1.5 hours.

REMARK : The fibre was easily separated, supple but had somewhat harsh feel

(e) The ammonium oxalate treated fibre was treated with 1% sodium hexameta phosphate solution at 120°C for 1.5 hour.

REMARK : The fibres were easily separated soft and supple.

The ammonium oxalate sodium hexametaphosphate treated fibre was stapled to about 50 mm, mixed with 3 denier polyesterstaple fibre (50 : 50), carded in a miniature cotton card, processed in a drawing frame, roved and spun in a ring frame. The spinning could be done smoothly and yarn of 34.7 Nm was prepared. The yarn was somewhat hairy. PTRI treated pineapple fibre (annexure III First Report) was also spun by the same procedure and yarn of 28.8 Nm was prepared. The yarn was also hairy.

Kenaf Fibre

(a) The fibre was treated with sodium sulphite solution (1.5%) at 140°C. for one hour, washed, woollenised and then boiled with sodium hydroxide solution (1%) for 2 hours.

REMARK : The fibres were well separated and soft

(b) The fibre was treated with 1.5% sodium sulphite solution (1 :2) at 120°C for 2 hours.

REMARK : Fibres were separated, bleached somewhat but not very soft

(c) The sodium sulphite treated fibre was treated with 1% sodium hydroxide solution at 120°C for 2 hours.

REMARK : Fibres were separated, soft & supple

The sodium sulphite-sodium hydroxide treated fibre was combed, stapled to 50 mm, and blended with 3 denier staple polyester (50 : 50) fibre, carded in a miniature cotton card, processed in a drawing frame, roved and spun in a ring frame. The spinning could be done smoothly and yarn of 34 Nm was prepared but the resulting yarn was hairy.

Banana Fibre

(a) The fibres were treated with sodium sulphite solution (1.5%) at 120°C for 2 hours.

REMARK : Fibres were separated, softened somewhat but still coarse and brittle

(b) The sodium sulphite treated fibres when treated with 1-2% sodium hydroxide solution at boil became matted or are disintegrated.

Maguey Fibre

(a) The fibre was treated with sodium sulphite solution (1%) at 160°C for 2 hrs.

REMARK : The fibres were soft

(b) Sodium sulphite treated fibre was treated with 18% sodium hydroxide solution at room temperature for two hours and then boiled with 1.5% sodium hydroxide solution for 1 hour.

REMARK : The fibres were softer and fine but the root portion was somewhat stiffer.

ABACA Fibre

The fibres were treated with sodium sulphite solution (1.5%) at 140°C for one hour. The fibre was then treated with 18% sodium hydroxide solution at room temperature for two hours and finally boiled with sodium hydroxide solution (1%) for 2 hrs.

REMARK : The fibres were fine and easily separated

RECOMMENDATIONS

Treatment procedure :

(a) To ensure proper handling of the fibres during pretreatment and proper separation of the fibres after pretreatment the procedure for treatment as mentioned earlier should be followed. The treatment of fibre at elevated temperature should preferably be conducted in a revolving digester.

Pretreatment :

Methods of pretreatments for fibres under consideration were already developed by PTRI earlier. The scientists from PTRI had attended the spinning trials at Leeds and LIRA and gained knowledge about their processing. They must have now sufficient information about characteristics and suitability of the fibres for textile processing so that they will be able to select the pretreated fibres for textile processing. If PTRI developed methods be considered only suitable methods of pretreatment of the fibres for textile processing, the methods should be adopted for making textile materials. It is recommended that alternative pretreatment methods suggested here should also be tried and compare with the PTRI methods for producing suitable textile materials economically.

Pineapple Fibres :

Mechanically softened pineapple fibre in blends with cotton/polyester/acrylic fibre can be made into suitable textile materials. But to improve its microbial resistivity it will be better if the fibre be given a suitable treatment such as enzymes or ammonium oxalite solution. For improvement of fibre quality sodium hexametaphosphate treatment with or without previous ammonium oxalite treatment as mentioned earlier should be tried. Enzyme treatment of fibre should be persued to improve the fibre quality.

Kenaf Fibre

Kenaf fibre had shown good fibre separation, suppleness and softness on treatment with sodium sulphite and followed by sodium hydroxide. It has to be explored for further improvement by varying the reaction conditions. Woollenisation may also be tried after initial Na_2SO_3 – NaOH treatments. The material after Na_2SO_3 – NaOH pretreatment should be tried for textile processing.

Banana Fibre

Banana fibre showed some difficulty in pretreatment. Sodium sulphite – sodium hydroxide treated fibre after mechanical softening may be tried for textile processing. Pretreatment with Na_2SO_3 (1%) and Na_2S (0.05 – 0.1%) at 115 – 120°C and followed by woollenisation if necessary may be tried.

Maguey Fibre

PTRI experiment on Maguey fibre produced fibre of improved softness and fineness on treatment with sodium sulphite followed by woollenisation and alakli boil. PTRI developed method and the method of pretreatment mentioned here should be followed to establish the reaction conditions to prepare the best type of fibre for textile processing.

Abaca Fibre :

It was observed in PTRI experiment that the abaca fibre on treatment with sodium sulphite followed by alkali treatment and woollenisation produced good fibre. The treatment need to be followed to establish the optimum conditions.

If the fibres pretreated by either PTRI or recommended methods are found suitable considering the fibre separation, softness, fineness and suppleness etc. for textile processing the material should be given trial for processing to textile material utilising the processing system most suitable for the material. The experience of the scientists who attended the processing trials at Leeds and LIRA will be helpful in that respect.

The pretreated fibres found suitable for textile processing should be tested for gum content, fineness, strength, softness and the results correlated with the textile processing performances.

PRODUCT DEVELOPMENT :

It has been shown that pretreated fibre can be made into suitable yarn by blending with other textile fibres. It is now necessary to prepare suitable fabric for commercialisation in a small way to have an idea about the consumers' reaction about the materials. Moreover some of the fibres are not produced in sufficient quanitties at present (Annexure – II, First Report) necessary for industrial production. If a demand for the fibres be created by producing and marketing suitable textile materials then the cultivators will be motivated to produce more fibre and that will certainly improve the economy of the cultivation of the plants.

At this stage it may not be necessary to consider for making apparel textile from all the indigenous fibres. Coarse yarn may be made into attractive upholstery or furnishing fabric. Pineapple fibre can certainly be made into apparel textile material. Fabrics properly made from the indigenous fibres has some aesthetic value and people will like them. Fabrics made from natural fibre and polyester or acrylic or cotton blended yarn have good look but harsh to feel due to protruted natural fibre. But the surface feel can be improved by singeing or by chemical treatment. A fabric prepared by PTRI from 75 : 25 polyester – kenaf blended yarn when treated with calcium hypochlorite solution at pH 6-7 for about 40-45 minutes, rinsed, treated with a solution of sodium sulphite, washed and then treated with a solution of cationic softening agent, removed the protruded fibres and made the fabric surface soft to feel. If cotton yarn is used as weft, the fabric will have a softer feel. If cotton or polyester cotton blended yarn be used as warp and blended natural fibre yarn as weft the natural fibre will not be ver much perceptible. Natural fibre specially pine-apple fibre can at least partially replace cotton in polyester – cotton blended yarn.

It is recommended that pretreated fibres so far developed should be processed to textile materials for various end uses. In that respect processing technology and selection of blending partners, considering their quality and quantity, have to be identified properly. The textile materials can be finished to remove the defects and then bleached, dyed or printed if necessary, to make the textile materials attractive to the consumers.

The work on pretreatment of the indigenous fibres, their processing and finishing of the textile materials should be continued based on the informations from the consumers reaction to improve the quality of the materials.

ANNEXURE - I

PROGRAM OF ACTIVITIES OF DR. P. C. DAS GUPTA
UNDP/UNIDO PROJECT DP/PHI/87/002
CY 1990

	ACTIVITIES	DATE
1.	Starting from Calcutta	January 27, 1990
2.	Arival at the NAIA	January 28, 1990
3.	Visit to UNDP Discussion with RDD Researchers	January 29, 1990
4.	Laboratory Experimentation on the Pretreatment of Indigenous Fibers	January 30 – February 14, 1990
5.	Plant Visit	
	a. Dymac (Mr. George Dy)	February 8, 1990
	b. Indo Phil. Textile Mills, Inc. Bo. Lambakan, Marilao Bulacan	February 15, 1990
6.	Trial Spinning of Degummed Fibers	February 15-21, 1990
7.	Visit to La Union and Baguio	February 18-20, 1990
8.	Lecture/Discussion with PTRI Technical Staff	February 22, 1990
9.	Report Preparation	February 23, 1990
10.	Departure at the NAIA	February 24, 1990
11.	Arrival at Calcutta	March 3, 1990