SITRA has developed a softening process to coir and sisal fibres. After softening coir fibres, the same can be blended with fibres like jute, sisal and hemp. Appropriate machinery modifications have been carried out in jute spinning system to produce coir/jute, coir/sisal and coir/hemp blended yarns. While using modified jute spinning system, it is possible to produce coir blended yarns of 25 to 60% finer as compared to 100% coir yarns produced by normal spinning process available in coir industries.

Spinning of coir/jute blended yarns in modified jute spinning system

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Coir fibres are elastic, resistant to seawater and also have high tear and abrasive strength. The biodegradable nature of coir fibres could help to raise the demand for coir products in the European markets in view of the growing concern for the environment in the quality of yarns from these ratts does not conform to the exporter's quality requirements.

Majority of the coir yarns spun using mechanized ratts are manufactured with cotton or polyester filament as core. Whenever cotton is used as core, the cost of the resultant coir yarn increases and when polyester filament is used as core, the eco-friendly nature of the coir product is affected.

SITRA in collaboration with Coir Board, Kochi has conducted a project on 'Spinning of coir blended yarns in jute spinning system'.

Sitra has developed a softening process to coir and sisal fibres. After softening coir fibres, the same can be blended with fibres like jute, sisal and hemp.

Materials and methods

Advantages of blending coir with other fibres like jute, sisal and hemp. The length/breadth (L/B) ratio that determines the spinnability of a fibre is 30 to 40 for coir, around 140 for jute, 160 for sisal and 900 for hemp. Hence, blending of coir with jute, sisal and hemp will improve the spinnability by way of reducing the flexural and torsional rigidities. The linear density of coir fibre (from 12 g/tex to 20 g/tex) as against 50 g/tex for sisal, 35 g/tex for jute and 40 g/tex for hemp. Hence, the coir-blended yarns will have relatively higher strength, which could be expected to improve the service life of the products made.

Sisal fibres are stronger, lustrous and easily dyeable to any shade. Blending of coir with sisal therefore, will help to improve the durability and the appeal characteristics of the end product. Moreover, sisal fibres have higher abrasion resistance with lower coefficient of variation as compared to that of coir. Hence, products made out of coir/sisal blends could be expected to have better wear life.

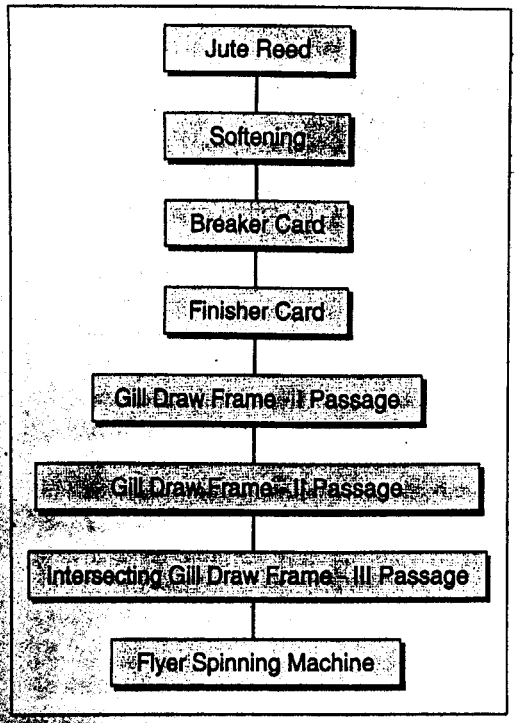

Fig 1 : Process flow chart for spinning 100% jute yarn

on coir fibres. The softening chemicals and softening parameters were chosen keeping in view the chemical composition and physical properties of coir fibres.

Spinning trials were carried out for coir/jute and coir/sisal blended materials (30/70, 40/60 and 50/50) using all the chemical and enzyme treated fibre samples in modified jute flyer spinning system. Based on the performance of the spinning trials, following softening treatment was found optimum for coir fibres :

Name of chemical	: Caustic Soda (Sodium Hydroxide)
Concentration	: 10%
Time	: 1 hr
Temperature	: Boiling

After caustic boiling, the fibres are washed, neutralised, treated with Magnesium Chloride (to retain the softness imparted to the fibres) and then dried.

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Chemically softened coir fibres were also tested for flexural rigidity using Ring Loop Method. In this method, a length of fibre is bent through 360° to form a ring. The ends are gripped and the distortion produced in the ring shape by some externally applied weight is observed. In these circumstances, the flexural rigidity G is given by the equation;

$$G = kWL^2\left[\frac{\cos\theta}{\tan\theta}\right]$$

where,

k = a constant, the value of which is around 0.0047

W = applied load in g

L = circumferential length of undistorted ring in cm

$\theta = \frac{493\ d}{L}$

d = deflection of lower end of the ring under action of applied load.

For greater sensitivity, a value of W is chosen such that θ lies between 40° and 50°. When W is given in grams and L and d in centimetres, the flexural rigidity is derived in units of $g.cm^2$ and has the dimensions ML^3T^{-2}.

The result of flexural rigidity of coir fibres, obtained using Ring Loop Method is as follows.

- Flexural Rigidity of Coir Fibres ($gf.cm^2$)
  - i) Before softening : 1.0793
  - ii) After Softening : 0.4611.

It is discernible from the above result that chemical softening reduces flexural rigidity of coir fibres by around 60%.

Spinning of coir/jute, coir/sisal and coir/hemp blended yarns in jute spinning system

About jute spinning system

The most commonly operated jute spinning system consists of two stages of carding, followed by three stages of drawing and finally a spinning stage. The flow chart given in *Fig 1.*

In the first carding stage, the long lengths of fibre are passed through a breaker card, which breaks the continuous mesh of fibres into separate fragments, conveniently called 'entities', fragmentation, the pins of the breaker card have a cleaning action by removing loosely adhering non-fibrous matter from the fibre proper.

Sliver from the breaker card is then passed through the second, or finisher card, which causes a little more fibre breakage and provides further opportunity for removal of non-fibrous matter. In addition, the finisher card has an important mixing effect, since a number of slivers are fed to the card in parallel and emerge finally as a single sliver.

In the three drawing stages, the movement of fibre is controlled by gill pins fixed to faller bars. In modern drawing frames, the faller bars move on spiral screws, although some spinners prefer the push-bar method for the first stage. At all stages, drafting is accompanied by appropriate doubling of the input slivers.

The output sliver from the final drawing stage then passes to the spinning frame, where its linear density is reduced suitably for the yarn being spun, after which the required twist is inserted. Almost universally in the jute industry, the insertion of twist is performed by overhung flyer, with the yarn winding-on to a bobbin rotating on a dead spindle, against a friction

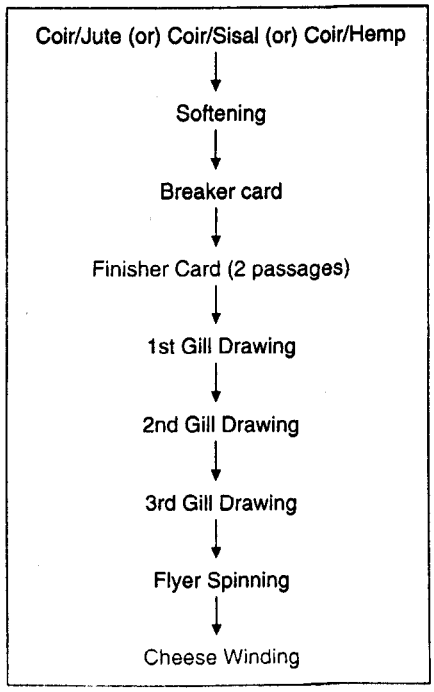

Table 1 : Length of coir fibres

Length (mm)	Proportion (%)
Upto 50	16.0
51 - 100	36.0
101 - 150	27.0
151 - 200	16.0
Above 200	5.0

drag. Other methods of inserting twist by ring or pot spinning are available but are little used, and then only for yarns of higher linear density.

Modification of jute machinery to spin coir/jute, coir/sisal and coir/hemp blended yarns

The major machinery modifications that have been carried out in jute spinning system to make it suitable for processing coir-blended yarns are listed below :

- Weight of crimping rollers was increased by about 20% for all preparatory machines (breaker card, finisher card and gill drawing - 3 Numbers).
- The depth of slots for crimping rollers was increased from 1.0 mm to 2.0 mm in all preparatory machines.
- The bush bearing system for all rotating parts of preparatory machines was replaced by ball bearing system.
- New types of faller bars suitable for processing coarser varieties of fibres in gill draw frame were incorporated.
- The top guides of flyers in jute spinning machine are made of chromium-plated steel. The same were replaced by ceramic guides for spinning coir blends.
- Ceramic coating was also provided for other parts of the Flyer spinning machines in jute spinning system. This helps for better spinning performance while spinning coir blends.
- The Flyer spinning machine used in jute spinning system is suitable for producing 100% jute yarns of runnage 3500 m/kg and 4500 m/kg. The gearing system of the same machine was that wide range of turns per unit of length can be imparted to yarn.

The process sequence of coir-blended yarns produced using modified jute spinning system is shown in *Fig 2.*

Optimisation of length for jute and sisal fibres

Jute, sisal and hemp fibres are available in reed form with 4 to 6 ft. in length. Hence, for blending them with coir fibre, they have to be cut into appropriate lengths. The following trials were conducted for optimisation of length of jute, sisal and hemp fibres meant for blending with coir :

- Coir fibres have a wide variation in length *(Table 1)*. Hence, Jute, sisal and hemp fibres were cut into 50 mm, 75 mm, 125 mm, 175 mm and 200 mm lengths.

The fibres of variable length were mixed together and blended with coir. The coir/jute, coir/sisal and coir/hemp blended materials were processed in jute spinning system after incorporation of necessary modifications. But the working performance at Gill Draw frame (2nd and 3rd) and Flyer spinning machine was found much inferior due to frequent breaks.

- Some trials were also conducted with different fixed cut lengths i.e. 100 mm, 200 mm, 300 mm, 400 mm and 500 mm of jute, sisal and hemp fibres for spinning of coir/jute, coir/sisal and coir/hemp blended yarns.

Based on breakage rate at Gill drawing and Flyer spinning machine and variation in weight per unit length of sliver, 300 mm fibre length was [illegible] for jute and sisal fibres.

Manufacture of coir/jute, coir/sisal and coir/hemp blended yarns in Modified jute spinning system

Both coir and sisal fibres were softened using the standard procedure as discussed in earlier sections. Turkey red oil of 2.5% fibres of 300 mm length (optimised fibre length for bulk spinning trials) and processed through breaker and finisher card. For proper blending two passages were provided at finisher card. The finisher card sliver is processed through three passages of Gill drawing frame for improving fibre parallelisation. In finisher carding and each Gill drawing machine, mechanised crimping (by slotted roller and over feed mechanism) is given at the delivery point to impart some sort of cohesion to the fibres in sliver. The 3rd drawing sliver is fed to the flyer-spinning machine for manufacturing coir-blended yarns.

The process parameters in modified jute spinning system to produce coir-blended yarns are given in *Table 2.*

At initial stage three types of coir/jute blended yarns and one type of coir/sisal/jute blended yarns were produced after optimisation of softening process and spinning process along with machinery modifications. The quality attributes of the yarns are given in *Table 3.*

During bulk trials, the following coir blended yarns *(Table 4)* were produced.

The above yarns were doubled using ring-doubling machine and the runnage varies from 380 m/kg to 485 m/kg. The runnage of two ply 100% coir yarns produced by automatic spinning machine ranges from 50 to 300 m/kg. In the case of manual

Table 2 : Process parameters in modified jute spinning system

Gill draw frame	
1st Passage	No. of doubling - 4 Draft : 6
2nd Passage	No. of doubling - 4 Draft : 6
3rd Passage	No. of doubling - 5 Draft : 8
Flyer spinning	
Spindle speed (rpm)	1000
T.P.I.	4.5
Ring doubling	
Spindle speed (rpm)	800
[illegible]	

Table 3 : Quality characteristics of coir blended yarns

Sr No.	Type of blended yarn	Blend proportion (%)	Runnage (m/kg)	Breaking force (Kgf)	Elongation (%)
1.	Coir/jute Single	30/70	948	4.40	5.10
2.	Coir/jute Single	40/60	583	4.10	7.40
3.	Coir/jute Single	50/50	803	3.60	9.30
4.	Coir/jute	30/70	418	8.20	5.75
5.	Coir/jute Double	40/60	313	9.10	10.40
6.	Coir/jute Double	50/50	436	9.10	6.10
7.	Coir/sisal/jute Single	25/30/45	781	4.10	10.65
8.	Coir/sisal/jute Double	25/30/45	350	11.70	10.00

Table 4 : Coir blended yarns

Type of Blend	Blend porportion (%)	Yarn type	Runnage (m/kg)
Coir/Jute	50/50	Single	800
Coir/Jute	40/60	Single	1000
Coir/Sisal	50/50	Single	800
Coir/Sisal	40/60	Single	900
Coir/Hemp	50/50	Single	800
Coir/Hemp	40/60	Single	800

operation (Hand spinning or spinning using traditional Ratt) normally achieved runnage of 100% coir yarn (2 ply) varies from 50 to 360 m/kg. But in case of modified jute spinning process, the achievable runnage of 2 ply yarns is 485 m/kg for coir/jute blended yarn, 395 m/kg for coir/hemp blended yarns and 380 m/kg for coir/sisal blended yarns. Hence, the modified jute spinning process helps to produce coir blended yarns of 25 to 60% finer as compared to 100% coir yarns produced by automatic spinning process used in coir spinning system.

rigidity of coir fibres by as much as 70%.

- To make conventional jute spinning machinery suitable to spin coir-blended yarns, appropriate modifications were carried out in breaker card, finisher card, gill drawing machines (3 passages) and flyer spinning machine.
- 300 mm cut length was found optimal for blending coir with other fibres like jute, sisal or hemp.
- Runnage of two ply 100% coir yarns produced by automatic spinning machine used in the coir system ranges from 50 to 300 m/kg. In case of modified jute spinning process, the maximum runnage of 2 ply yarns obtained is 436 m/kg for yarns produced by automatic spinning process used in the coir industry.

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