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***Research Paper***

# Utilization of agro waste-okra and its potentiality

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■ **ABSTRACT :** Sustainable use of renewable natural resources is a present day demand. To maintain a ecological balance in the environment, a study was conducted to extract fibre from the waste stem of okra plant and its utilization for making different utility products to fulfil day today needs. The physico-chemical properties such as microscopic structure, IR spectra, length and breadth of fibre, tensile strength, elongation and chemical constituents of bhindi fibre were evaluated. Six different types of products were made and these suitability was tested by a panel of judges and found that the functionality of the developed products were suitable for its intended purpose

■ **KEY WORDS:** Extraction, Retting, IR spectra, Non woven, Optimization

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Agro-waste is the green waste in agricultural field which sometimes create environmental problem when it is abundantly excreted. But recycling of those waste for productive purposes can minimise the pollution and help in waste management. And it is considered as the key activity of clean technology. Therefore, it is thought to be the duty of present day researchers to use those bio-mass for productive purposes. Keeping in view, the present study was conducted on extraction of fibre from waste okra plants left in the farmers field after harvesting its edible fruits. It is noted that okra is a major vegetable crop of India as well as in Assam. It is a plant of the Malvaceae family, known botanically as *Abelmoschus esculentus* Linn (Facciola, 1990) and widely grown as summer vegetable crops (Kochlar, 1986).

Considering the potentiality of this versatile fibre proposed research work was carried out with the following objectives.

– Extraction of fibre from waste okra plants.
– Analysis of physico- chemical properties of okra fibre.
– Product development from okra fibre.

## ■ RESEARCH METHODS

### Collection of materials:

The waste okra plants were collected from farmers field from Jorhat and Gulaghat districts of Assam after hervesting the edible fruits.

### Extraction of fibre :

Extraction of fibre from okra plants were carried out by water retting. The separation of the bast fiber from the xylem tissues is possible only after the retting process. The long stem of fibres were kept under water to allow microbial degradation the degraded stems

appreciably to allow fibre extraction. The fibre were isolated from the stem by being washed in running water. All the extracted fibres were line dried under shade for 24 hours and then subjected for further treatments.

**Optimization of time for water retting**:

I kg of mature okra stems were used for optimization of time for retting process. Water retting was done for different time intervals from 3 days, 6 days, 9 days, 12 days and 15 days. While extraction, care was taken to remove the impurities that adhered in the fibres. All the extracted fibres were line dried under shade for 24 hours and then subjected for further treatments.

The fibres were extracted in bulk. Yield of the fibre were recorded using the following formula :

$$\text{Yield (\%)} = \frac{\text{Weight of the fibre}}{\text{Weight of the waste okra stem} \times 100}$$

**Fig. A : Removed the fibres from the body of the plant**

**Wet processing treatments:**

*Degumming :*

Degumming was carried out with 1 per cent sodium carbonate ($Na_2CO_3$) solution for 30 minutes and acidified with acidic acid. It was then washed properly in clean running water (Gogoi, 2004).

*Bleaching :*

Bleaching of degummed fibres were done by weighing the fibre accurately. Required quantity of water was taken (M: L =1:50) and heated to required temperature. 1 per cent hydrogen peroxide was added to the liquor. Sodium silicate was added to the bleaching bath as a stabilizing agent in the middle of the process. Fibres were taken out after 30 minutes and washed properly in running water and air dried (Gogoi, 2004).

**Analysis of physico- chemical properties of okra fibre:**

Microscopic structure, physical and chemical properties of okra fibre were tested using different procedures as mentioned below:

**Microscopic structure:**

The microscopic appearance of a fibre is an important criterion that helps a researcher to know the basic structure of the fibre both in longitudinal and cross section. Okra fibres were subjected to study their longitudinal structures using Olympus Microscope. (Bledzki *et al.*, 1996).

**IR study of the fibre:**

Five samples of okra fibre were subjected to show the absorption band and it was recorded in a double beam spectrophotometer. The sample was made with dry KBr (Potassium bromide) and powdered samples were placed in the sample holder of the instrument while a blank KBr. Pellet was placed in the reference beam.

**Fibre elongation (%) :**

Elongation percentage is the ability of fibre to stretch or extend. Higher elongation percentage enhances the spinning ability of the fibre. Elongation of the okra fibres was analysed using single yarn strength tester.

**Chemical analysis:**

Analysis of chemical constituents of okra fibres were carried out by using TAPPI and standard bio chemical methods.

**Solubility :**

Solubility test gives an indication of the extent to which the polymers of fibre may react with common degrading agents such as acids, alkali, solvents, laundering agents, atmospheric pollutant etc. (Gohl and Vilensky, 1987). The fibre were treated with alkali ($Na_2CO_3$, NaOH), acid ($H_2SO_4$ and HCl) and solvents (methanol and acetone).

**Product development from okra fibre:**

Considering the properties of okra fibre some of the utility products were developed and the cost of each of the products were finalized based on the material cost and labour cost.

Non-woven fabrics were also prepared from 100 per cent okra fibre and blending the fibre with jute fiber in 4 (four) different ratio *i.e.* 80:20, 70:30, 60:40 and 50:50.

The work was done at National Institute of Research on Jute and Allied Fibre Technology (NIRJAFT), Kolkatta.

**Assessment of developed products:**

The prepared products were assessed in five point scale by thirty (30) number of judges in terms of its aesthetic appeal of the product, workmanship and finishing, appropriate designing of the product according to intended use and product distinctiveness from regular commercial product and its Weighted Mean Score (WMS) was recorded.

## ■ RESEARCH FINDINGS AND DISCUSSION

The findings of the study were discussed under the following headings :

**Optimization of okra fibre by water retting :**

It was found that the plants were soften completely and fibres came out easily after 15 days time period of retting. Hence, based on the yield of fibres the duration of retting for extraction of fibres from okra plants were optimized (Table 1).

**Table 1 : Optimization of bhindi fibre by water retting**

| No. of days | Appearance | Yield percentage |
|---|---|---|
| 3 | No change | - |
| 6 | Slightly soften | - |
| 9 | Partially soften | - |
| 12 | Soften but not fully removed | - |
| 15 | Completely removed | 40 g/ |

**Yield of the fibres** :

Average yield of fibres was 40 g/ kg. Similar result as 180 kg/ acre was reported by Brinchi *et al.* (2013).

**Analysis of physico- chemical properties :**

The physical properties of fibre such as microscopic appearance, fibre length, breadth, wall thickness and tenacity were analysed and presented in Table 2. An alternative term for tenacity is the specific strength of the fibre or the mass stress at break is express in grams per denier or per tax is given below :

**Microscopic structure**:

The microscopic structure helps in identifying and explaining about the behaviour of fibres. In longitudinal view, okra fibre appeared as rod like structure (Fig. 1). It has gummy layer on its surface with prominent but irregular scale marking.

**Table 2 : Physical properties of bhindi fibres**

| Sr. No. | Properties | Unit |
|---|---|---|
| 1. | Fibre length(mm) | 2.72 ± 0.08 |
| 2. | Fibre breadth (mm) | 0.262 ± 0.00072 |
| 3. | Cell wall thickness(mm) | 4-5 |
| 4. | Tenacity in bundle | 22.62g/tex |
| 5. | Colour | White/ light cream or yellowish in colours |

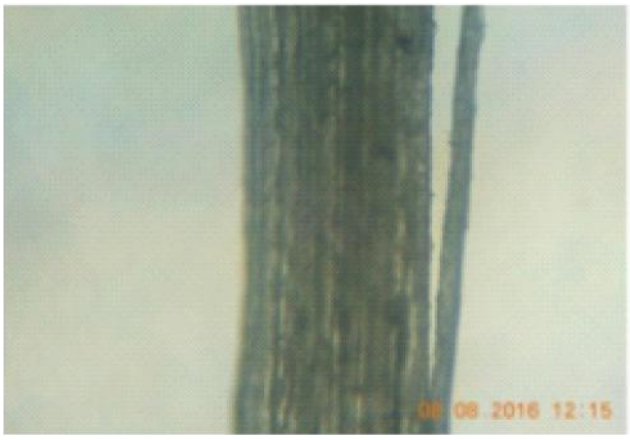

**Fig. 1 : Longitudinal view of fibre**

**Infra- red spectra of the fibre:**

Infra- red spectra of the fibre showed absorption band of C-H and C=O group at 2975 cm and 1730 cm pick, respectively.

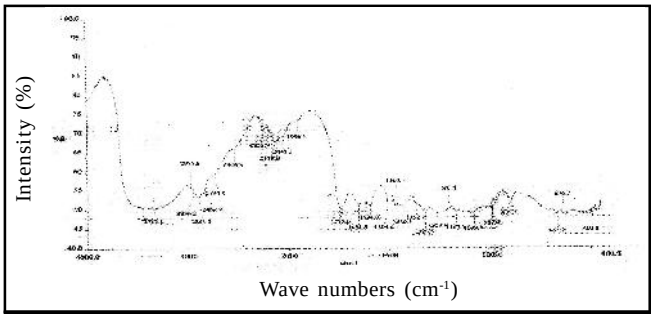


**Fig. 2 : Infra ray spectra of Lady's finger**

**Chemical composition of okra fibre**:

Table 3 highlighted that, chemical composition of okra fibre showed highest cellulose content (65.5%) followed by ash (15.8%) and lignin (13.8%), respectively. A less amount of pectin (1.0%) and 3.9 per cent of fatty waxy matter were found in okra fibre. The finding of

**Table 3 : Chemical compositions of Bhindi fibre**

| Sr. No. | Chemical constituents | % |
|---|---|---|
| 1. | Cellulose | 65.5 % |
| 2. | Ash content | 15.8 % |
| 3. | Pectin matter | 1.0 % |
| 4. | Fatty waxy matter | 3.9 % |
| 5. | Lignin | 13.8 % |

the chemical constituent of okra is highly supported by the result found by Jain (2012) and Kumar *et al.* (2013). The okra fibre posses an excellent quantity of cellulose. Hence it can be used as cellulosic raw materials in cellulose based industries. It also contains low percentage of lignin, which is responsible for yellowing and photochemical degradation (Kumar *et al.*, 2013).

**Solubility:**

Table 4 revealed that acid affected okra fibre greater than other chemical like alkali and solvents. It was completely dissolved in $H_2SO_4$ acid.

**Products development from okra fibre:**

Product development is an essential part of any research to be viable. Okra fibres extracted in the present study were utilized for making different products. Suitability of prepared products was assessed through different parameters.

Products made from raw okra fibre are :

**Cleaning brush:**

Brush with wooden handle was made from degummed okra fibre used for cleaning of table tops and other area.

**Painting brush**:

Soft and pliable brush can be used for painting purpose was made from okra fibre.

**Shoe brush**:

Okra fibres can also be used for making different types of shoe brushes.

**Rope:**

Rope is of paramount importance in fields of agriculture and others can be constructed with okra fibre. It can also dyed with natural or synthetic colour.

**Cleaning brush**

**Shoes brush**


**Painting brush**

**Rope**

**Fig. 3 : Photograph of products developed from bhindi fibre**

**Table 4 : Solubility test of bhindi fibre**

| Sr. No. | Acid (conc.) | | Alkali | | Solvent | |
|---|---|---|---|---|---|---|
| | $H_2SO_4$ | HCl | $Na_2CO_3$ (5%) | NaOH (5%) | Methanol | Acetone |
| 1. | Soluble | Soluble | Not soluble | Partially soluble | Not soluble | Not soluble |

**Cost estimation of the products :**

The costs of the products were estimated based on actual material cost (fibres), cost of accessories and labour cost (200/8 hours) in making the products**.**

**Evaluation of products made from okra fibre :**

The Table 5 highlighted the evaluation of products shown in the photographs and it was found that the aesthetic appeal of cleaning brush was highest (4.03), followed by painting brush (3.9) and shoe brush (3.9), Regarding the workmanship and finishing of the product similar results were found for painting brush and show brush *i.e.* 3.9 followed by rope 3.8 and cleaning brush 3.6. The designs of the products are appropriate according to intended use and all those prepared products are distinctiveness from regular commercial products.

**Paper from okra fibre:**

Okra fibers were used for making handmade paper. The paper fibre laminated can be formed easily by adding upto 70 per cent wt of the fibre.

The GSM (gram per square metre) of prepared paper were from 100 $Gm^{-2}$-180 $Gm^{-2}$**,** tensile index 3.27-3.63 $Nmg^{-1}$, and brightness (%) were 35.05 - 25.91. The colour of the paper was light cream colour. The paper fibre laminated having okra fibres show excellent properties and can easily replace expensive paper corrugated composites currently used by the packaging industry (Agrawal *et al.*, 2004). Cellulosic fibres extracted from the plant bast appear to be particularly suitable for polymer reinforcement purposes (Moniruzzaman *et al.*, 2009).

**Non –woven fabrics from okra and okra jute non woven fabric :**

*Visual assessment of non -woven fabrics :*

Above findings showed that non woven fabric of okra : Jute 50:50 ratio scored highest (Rank 1) in terms of general appearance (4.66), colour (4.50) and handle (4.33) followed by 100 per cent okra non woven fabric.

**Fig. 4 : Laminated paper in round and square shape**

**Table 5 : Cost estimation of products**

| Sr. No. | Name of the products | Requirement of fibre | Rate /kg(Rs.) | Production cost (Rs.) | | | Total (Rs.) |
|---|---|---|---|---|---|---|---|
| | | | | Cost of fibre | Cost of the accessories | Labour cost | |
| 1. | Painting brush | 10 g | 50.00 | 5.00 | 10.00 | 25 | 40.00 |
| 2. | Shoe brush | 15 g | 5000 | 10.00 | 10.00 | 25 | 45.00 |
| 3. | Dust cleaning brush | 25 g | 50.00 | 15.00 | 20.00 | 30 | 65.00 |
| 4. | Rope | 20-40 g | 50.00 | 10.00 | - | 20 | 30.00 |

**Table 6 : Evaluation of products from okra fibre**

| Sr. No. | Parameters | Cleaning brush | Painting brush | Shoe brush | Rope |
|---|---|---|---|---|---|
| 1. | Aesthetic appeal of the product | 4.03*** | 3.9*** | 3.9*** | 3.0*** |
| 2. | Workmanship and finishing of the product | 3.6*** | 3.9*** | 3.9*** | 3.80*** |
| 3. | Appropriate designing of the product according to intended use | 3.87*** | 3.87*** | 3.87*** | - |
| 4. | Product distinctiveness from regular commercial products | 2.33** | 1.8** | 2.87*** | 4.*** |

Rank 1 ***, Rank 2 **, Rank 3 *

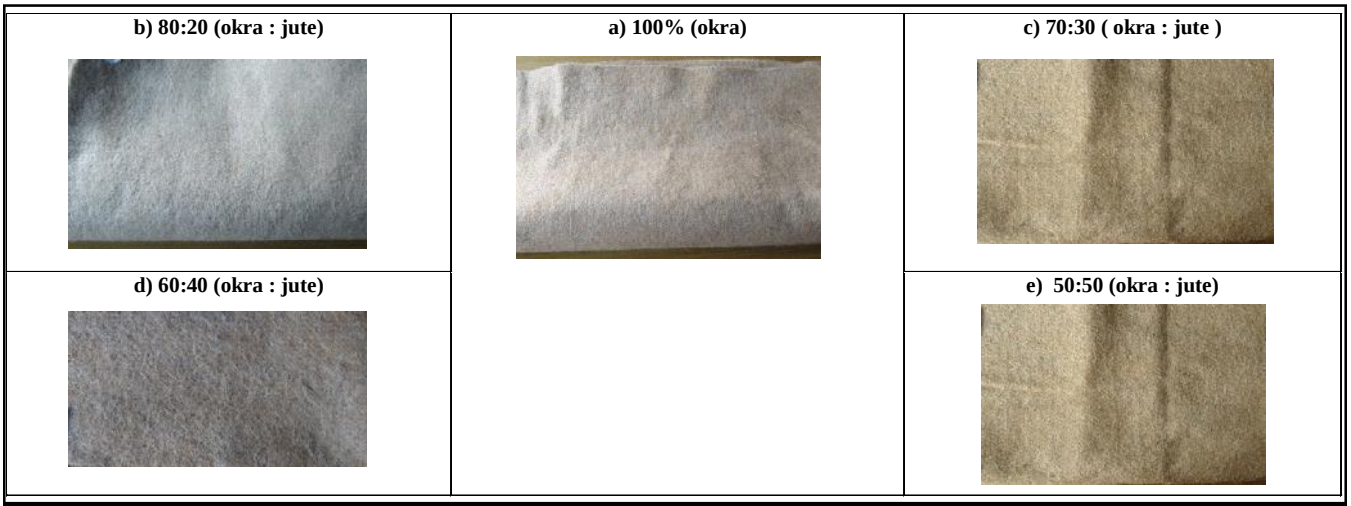


**Fig. 5 : Non-woven fabrics from okra and okra jute non woven fabric-non-woven fabric in different ratio**

**Table 7 : Visual assessment of non woven fabrics**

| Non woven fabric | General appearance | Colour | Handle |
|---|---|---|---|
| 100% Bhindi | 4.50* | 4.00** | 3.66* |
| 80:20 bhindi : Jute | 3.66 | 3.00 | 3.73** |
| 70:30 bhindi : Jute | 3.83 | 3.66* | 3.66* |
| 60:40 bhindi : Jute | 4.53** | 3.16 | 3.50 |
| 50:50 bhindi : Jute | 4.66*** | 4.50*** | 4.33*** |

Rank 1 ***, Rank 2 **, Rank 3 *

## Summery and conclusion :

From the study it could be concluded that some of the agricultural waste is no longer an environmental issue as we may extract tremendous potentiality from such a waste products. By using our own knowledge as well as scientific advancement we can change that waste to the wealth which can promote economic up-liftment of the society. Bast fibre extracted from okra has many of the desirable qualities of non-conventional fibre and it could be utilized for production of different cost effective household items. Production of fibre from okra can generate positive environmental benefits, thus contributing to the sustainable development in agricultural field which in turn create dual benefit from single crop. The technology will also highly encourage the okra grower for its large scale production.

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