# CHEMICAL PULPING OF SYLHET GRASSES.

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## S U M M A R Y.

Pulping experiments have been conducted on Ekra (Erianthus Ravennae), Khagra (Saccharum Spontaneum) and Nal (Phragmites Karka) - three grass species of Sylhet District of East Pakistan for the manufacture of writing, printing, wrapping and special types of papers. The grasses were cooked individually and in various percentages of mixtures. Effect of the presence and absence of leaves during cooking have also been studied. Results indicate that the grasses would be suitable for making various grades of papers.

## I N T R O D U C T I O N.

Ekra, Khagra and Nal are grasses of world-wide disstibution. These are available in abundant quantities

in Sylhet District of East Pakistan, They grew gregariously in the swamps to a maximum height of eighteen feet and a girth of three inches. The stalks are covered by the overlapping sheaths of the leaves. Khagra has a comparatively solid stem, the other two being hollow with wide set internodes. The principal use of the grasses at present is as fuel wood for burning lime-stone for the cement factories. Rural population however, use them for making walls and ceilings of kutcha houses.

The grasses cover about 20,000 acres in the Sylhet District and more than 125,000 tons of grasses can be extracted annually. (1) A paper mill with a daily production of 100 tons of papers can run perpetually on the basis of these raw materials.

Raitt (2) studied the different varieties of grasses, including the three species under investigation, grown in the Indo-Pakistan sub-continent. However, his work was limited to only soda pulping of the grasses. He reported that the nodes were comparatively difficult to pulp than the internodes. The present authors also notice the same. Crushing of the nodes, eases the problm to a great extent. Raitt concluded that Nal and Khagra were very good raw materials for pulping, with nal slightly superior to Khagra. He found Ekra to be inferior to the other two.

Bhat and Virmani (3) of the Indian Forest Institute

studied Nal for making paper pulp. Chemical and soda pulps were made and tested for strength properties. Their report concluded that nal could be utilised for paper making only when a certain percentage of a longer fibred pulp was mixed with the nal pulp. Results reported by Japan Consulting Institute (4) and U.S. Forest Products Laboratory (5) are at variance with those of Raitt and Bhat. Even Raitt could not agree with Bhat on yield, fibre-length and other physical properties.

East Pakistan Forest Industries Development Corporation is establishing a paper mill at Sylhet with these grasses as raw materials. Experiments have been conducted on these grasses both in mature and immature conditions, with leaves and without leaves, individually and in mixtures of varying proportions.

## M A T E R I A L S.

A consignment of Ekra, Khagra and Nal was sent by the East Pakistan Forest Industries Development Corporation from Sylhet District. These were seperated into mature and immature ones. A second consignment received later was mostly immature in nature. The two consignments have been designated as old and new in this study. The semi-dry grasses were hand-cut into two-inch lengths, and air dried. The chips were stored in sealed polyethylene bags at 5°C. Average

fibre dimension and chemical composition of the grasses are given in table 1.

## EXPERIMENTAL.

A stainless steel 0.8 cubic foot laboratory model rotating digester heated by indirect steam was used for pulping the grass chips by the kraft process. Five pounds of chips (Moisture-free basis) was charged in each of the cooks. The cooking conditions are given in table II. In all 20 cooks were made. A cook was made at the outset with equal quantities of the three grasses to determine the approximate cooking conditions, in which 42.5 grammes per litre NaOH, and 14.4 grammes per litre $Na_2S$ with an active alkali content of 17% were used. Time taken to reach the maximum temperature of cooking ($170^{\circ}C$) was 45 minutes. At the maximum temperature cooking was continued for another hour. Both the consumption of chemicals and pulp yield were on the lower side.

In the subsequent cooks percentages of chemicals used were lowered down to 38.3 and 13.00 grammes per litre of NaOH and $Na_2S$ respectively to make the percentage of active alkali in the cooking 16. Time and temperature schedule was kept as in the first cook.

Various cooks were made with or without leaves, with mature and immature varieties of grasses and with mixtures of each other. (Table II.)

At the end of the digestions the black liquor was drained off with the steam generated inside the digestor. The chips were then dumped into a screen box. The cooked chips were totally reduced to pulps in the digester. The pulps were then washed and passed through a vibratory screen with 0.012 inch wide slits. The screened pulps were damp-dried, shredded, weighed and sampled for moisture content. Strength tests and yield determinations of the pulps were then conducted. The yields of the screenings were also determined. (Table II.)

Strength properties of the pulps were determined by beating various periods of time to take the freeness value (Canadian Standard) to 450 c.c. and 250 c.c. (table III and IV.)

## RESULTS AND DISCUSSIONS.

Raitt reported that the lengths of Khagra and Nal fibres averaged 2 millimetres and their fibre diameter averaged 0.016 and 0.015 millimetres respectively. In his opinion Ekra was inferior to both nal and khagra in quality for making paper pulp. Bhat obtained the average fibre length of nal chemical pulp to be 1.200 mm. and average diameter 0.012 mm. Koizumi (4) found the average fibre length of the grasses to be from 1.05 to 1.23 mm. The fibre length and fibre diameter obtained by Das (1) are at variance with those obtained by Raitt. Our results agrees with those of Raitt -- that ekra has shorter fibre than the other two.

Yield of nal and khagra pulps decrease when cooked with leaves but presumably because of the presence of fibrous raw materi-l -als in the leaves of ekra, the yield of ekra pulp shows a little upward trend when cooked with leaves. Optimum condition of cooking gives a maximum yield of 47.36% for the mixed species.

In this study, unlike all other experiments done earlier, maturity, presence or absence of leaves and effect of varying the percentages of the grasses in mixture were taken into consideration. Tear values obtained from all the species at 450 freeness (C.S.) tend to improve when leaves are omitted. Cooking with or without leaves and sheaths would not alter other results appreciably. This is evident from the results incorporated in table lll and lV. Tear values of Nal seem to be a little better than those of ekra and khagra. This does not conform with the findings of the Forest Products Labrotory (5), where, it has been claimed that the tear values of nal averaged about 85% of the same for ekra and khagra. Tear values of ekra at 450 Canadian Standard Freeness seem to be better than those of the other two. At 250 Canadian Standard Freeness the tear values do not show any appreciable difference for the three species. Apparently tear values of nal and khagra increase when pulped with leaves.

At 450 C.S.F. burst factor for nal has been found to be 16.8 and 17.1 in cooks done without and with leaves

respectively. These values are lower than those found for ekra and khagra (table 111). At 250 C.S.F. also nal has poorer bust factor than the other two.

Both burst factor and breaking length values of nal and khagra increase if the cooks are made with leaves, whereas, contradictory results are given by ekra. It is interesting to note that ekra, but not the other two follow the predicted course for those values. The leaves being devoid of any long fibres, should have a detrimental effect on the strength properties of the pulps.

Folding endurance values (double folds) of the grasses are generally very poor but improve considerably with falling freeness values. Mostly from single figure it goes to even four figure values.

Immature grasses yield pulps having better strength properties than the mature ones. This happens probably becaus -e a large quantity of sugar is present in the grasses and fermentation sets in rapidly in themature grasses. As a result -t, the condition of the fibres deteriorates progressively with time.

Broadly speaking, physical properties of the three grasses are almost of the same nature.

The results obtained for the mixtures of the grasses average those obtained for individual grasses. Variation

in the percentages of the mixtures does not have any appreciable effect on the results. Equal proportions of the grasses give a slightly better result than when mixed in the proportion of their availability in the swamps. Strength properties of the various mixtures of the three grasses (Cook Nos.1, 16, 17,18,& 19) are presented in graphical form.

## CONCLUSION.

Ekra, khagra and nal may be mixed in equal proportions to produce writing, printing and wrapping grade papers. Cooking with or without leaves and sheaths would not alter other results appreciably. Special types of papers like tissue and typing papers may also be made from these grass species.

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TABLE - 1.

Chemical Composition and fibre dimension of Ekra, Khagra and Nal.

| Species. | Lignin Percent. | Solubility in. | | | Fibre length m.m. | Fibre diameter m.m. |
|---|---|---|---|---|---|---|
| | | Alcohol-Benzene. percent. | 1% NaOH solution percent. | Hot water percent. | | |
| Ekra. | 20.9 | 5.3 | 32.6 | 8.5 | 2-214 | 0.0144 |
| Khagra. | 19.4 | 3.5 | 31.0 | 4.6 | 2.612 | 0.0161 |
| Nal. | 19.3 | 10.2 | 34.8 | 13.8 | 2.464 | 0.0145 |

TABLE - 11.

Cooking conditions of the grasses.

| Cook No. | Species used. | Chemicals consumed. | Yield % | Screening % | $KMNO_4$ No. |
|---|---|---|---|---|---|
| 1. | Ekra, Khagra & Nal 33:33:33: proportion. | 73.7 | 36.0 | 0.5 | 8.67 |
| 2. | Nal without leaves. | 88.5 | 46.7 | 0.2 | 13.65 |
| 3. | Nal with leaves. | 85.5 | 45.5 | 0.58 | 15.25 |
| 4. | Ekra, without leaves. | 77.0 | 40.0 | 0 | 9.40 |
| 5. | Ekra with leaves. | 74.9 | 43.0 | 0 | 8.30 |
| 6. | Khagra without leaves. | 74.0 | 47.4 | 0.36 | 7.70 |
| 7. | Khagra with leaves. | 76.0 | 40.6 | 0.50 | 10.75 |
| 8. | Khagra immature. | 83.25 | 38.0 | 0 | 7.79 |
| 9. | Ekra immature. | 74.9 | 42.6 | 0 | 10.00 |
| 10. | Nal immature. | 82.9 | 46.6 | 0 | 12.8 |
| 11. | Nal mature:immature 70: | 88.0 | 42.9 | 0 | 14.72 |
| 12. | Ekra with leaves. Mature:Immature: 70: | 80.5 | 42.66 | 0 | 7.95 |
| 13. | Khagra with leaves. Mature : Immature: 70 : 30 : | 31.5 | 41.3 | 0 | 8.34 |
| 14. | New Nal without leaves. | 85.05 | 43.4 | 0 | 9.76 |
| 15. | New Nal with leaves. | 83.26 | 43.5 | 0 | 11.48 |
| 16. | Mixture of old Nal: New Ekra:New Khagra with -out leaves.33:3 : 33.3 : 33.3 | 86.61 | 43.9 | 2.63 | 15.64 |

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|---|---|---|---|---|---|
| 17. | Old Nal : New Ekra : New Khagra without leaves. 60:20:20 | 86.98 | 47.36 | 0.633 | 12.26 |
| 18. | Old Nal : New Ekra New Khagra, without leaves. 50:25:25 | 81.62 | 42.6 | 0.885 | 11.18 |
| 19. | New Nal : New Ekra : New Khagra, 33.3 : 33.3: 33.3 | 78.12 | 42.25 | 0.536 | 11.38 |
| 20. | New Khagra without leaves. | 81.02 | 43.53 | 1.62 | 8.24 |

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In Cook No. 1, 42.5 G/L NaOH, 14.4 G/L $Na_2S$ and 17% active alkali were used. In all other cooks 38.3 G/L NaOH, 13.0 G/L $Na_2S$ and 16% active alkali were used. All the cooks were made at a maximum temperature of 170°C. Time used at the maximum temperature was 1 hour and time taken to reach the maximum temperature was 45 minutes.

TABLE - 111.

Strength properties of grass pulps at 450 C.S.F.

| Cook No. | Species used. | Density | Tear factor. | Burst factor. | Breaking length metre. | Folding endurance (df) | Beating time. (min) |
|---|---|---|---|---|---|---|---|
| 1. | Ekra, Khagra & Nal. 33 : 33 : 33 proportion. | 2.53 | 0.71 | 13.3 | 1400 | 13 | 10 |
| 2. | Nal without leaves. | 2.53 | 0.77 | 16.8 | 3705 | 43 | 6 |
| 3. | Nal with leaves. | 2.16 | 0.71 | 17.1 | 4530 | 28 | 5 |
| 4. | Ekra without leaves. | 2.54 | 1.02 | 27.7 | 4015 | 65 | 6 |
| 5. | Ekra with leaves. | 2.54 | 0.84 | 20.1 | 3553 | 22 | 5 |
| 6. | Khagra without leaves. | 2.22 | 0.81 | 18.4 | 3742 | 14 | 11. |
| 7. | Khagra with leaves. | 2.40 | 0.80 | 20.0 | 4870 | 30 | 10.5 |
| 8. | Khagra Immature. | data could not be taken. | | | | | |
| 9. | Ekra Immature. | 2.19 | 0.74 | 31.4 | 4400 | 94 | 0 |
| 10. | Nal Immature. | data could not be taken. | | | | | |
| 11. | Nal Mature:Immature. 70 : 30 | 2.46 | 0.72 | 27.9 | 5780 | 53 | 3 |
| 12. | Ekra with leaves. Mature : Immature. 70 : 30 | 2.23 | 0.76 | 18.4 | 3480 | 31 | 6 |
| 13. | Khagra with leaves. Mature : Immature. 70 : 30 | 2.27 | 0.68 | 20.8 | 4491 | 24 | 4 |
| 14. | New Nal without leaves. | 2.39 | 0.71 | 12.47 | 3723 | 10 | 5 |

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|---|---|---|---|---|---|---|---|
| 15. | New Nal with leaves. | 2.35 | 0.73 | 16.67 | 4211 | 11 | 2 |
| 16. | Old Nal + New Ekra + New Khagra without leaves. | 2.41 | 0.89 | 20.16 | 4820 | 39 | 9 |
| 17. | Old Nal + New Ekra + New Khagra without leaves. 60:20:20 | 2.17 | 0.78 | 9.55 | 2665 | 16 | 7 |
| 18. | Old Nal + New Ekra + New Khagra without leaves.50:25:25 | 2.31 | 0.92 | 18.30 | 3715 | 14 | 9½ |
| 19. | New Nal + New Ekra + New Khagra 33.3 : 33.3 : 33.3 | 2.29 | 0.67 | 14.00 | 3514 | 9 | 9½ |
| 20. | New Khagra without leaves. | 2.10 | 0.58 | 19.81 | 4781 | 26 | 13 |

TABLE - IV.

Strength properties of grass pulps at 250 C.S.F.

| Cook No. | Species used. | Density | Tear factor. | Burst factor. | Breaking length metre. | Folding endurance (df) | Beating time. (min.) |
|---|---|---|---|---|---|---|---|
| I. | Ekra, Khagra and Nal.33:33:33: proportion. | 2.08 | 0.78 | 25.4 | 5335 | 169 | 19 |
| 2. | Nal without leaves. | 2.14 | 0.75 | 25.05 | 4042 | 180 | 12 |
| 3. | Nal with leaves. | 2.20 | 0.81 | 33.74 | 6049 | 213 | 12 |
| 4. | Ekra without leaves. | 2.23 | 0.89 | 43.50 | 5707 | 331 | 15 |
| 5. | Ekra with leaves. | 1.90 | 0.68 | 37.87 | 4966 | 157 | 14 |
| 6. | Khagra without leaves | 1.86 | 0.57 | 29.20 | 4664 | 90 | 19 |
| 7. | Khagra with leaves. | 2.16 | 0.78 | 35.58 | 5328 | 73 | 16 |
| 8. | Khagra immature. | 2.09 | 0.68 | 40.20 | 5473 | 934 | 4 |
| 9. | Ekra immature. | 1.77 | 0.68 | 50.20 | 6190 | 693 | 9 |
| 10. | Nal immature. | 1.94 | 0.71 | 55.30 | 5708 | 1539 | 5 |
| 11. | Nal Mature:Immature. 70 : 30 | 1.94 | 0.67 | 45.90 | 7200 | 383 | 11 |
| 12. | Ekra with leaves. Mature : Immature. 70 : 30 | 1.87 | 0.64 | 30.45 | 4905 | 183 | 13.5 |
| 13. | Khagra with leaves. Mature : Immature. 70 : 30 | 1.70 | 0.59 | 30.50 | 6370 | 177 | 11 |
| 14. | New Nal with leaves. | 1.99 | 0.72 | 27.00 | 5420 | 89 | 14 |
| 15. | New Nal with leaves. | 1.97 | 0.71 | 30.30 | 6432 | 75 | 10 |

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|---|---|---|---|---|---|---|
| 16. Old Nal + New Ekra + New Khagra without leaves. 33.3:33.3: 33.3 | 2.11 | 0.86 | 32.20 | 6452 | 133 | 17.5 |
| 17. Old Nal + New Ekra + New Khagra without leaves.60:20:20 | 1.94 | 0.79 | 23.3 | 3840 | 43 | 15 |
| 18. Old Nal + New Ekra + New Khagra without leaves. 50:25:25 | 2.09 | 0.88 | 31.08 | 5060 | 126 | 19 |
| 19. New Nal + New Ekra + New Khagra. 33.3:33.3:33.3 | 2.05 | 0.76 | 27.18 | 4917 | 52.0 | 18 |
| 20. New Khagra without leaves. | 1.90 | 0.56 | 26.36 | 5790 | 85 | 18. |

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