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# A preliminary study on kenaf (*Hibiscus cannabinus* L.) accessions for fibre and pulp production

(Kajian awal aksesi kenaf (*Hibiscus cannabinus* L.) untuk penghasilan serabut dan pulpa)

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Key words: kenaf (*Hibiscus cannabinus* L.), fibre, pulp, yield, morphology

**Abstrak**

Kenaf (*Hibiscus cannabinus* L.) merupakan pokok semusim daripada famili Malvaceae yang digunakan sebagai bahan asas dalam penghasilan tali, karung, kanvas dan permaidani. Sejumlah 16 aksesi kenaf telah dikaji dari segi pertumbuhan termasuklah bentuk daun, pigmentasi batang, saiz biji benih (mengikut isipadu) dan fenologi bagi setiap aksesi. Bentuk daun terbahagi kepada jejari atau bulat. Pigmentasi batang pula adalah hijau muda, hijau gelap atau hijau kemerahan dan ini boleh dibezakan antara aksesi. Aksesi MK 13, MK 12, MK 23 dan MK 22 ialah yang tertinggi manakala aksesi MK 19, MK 13, MK 04 dan MK 28 mempunyai diameter batang yang terbesar. Aksesi yang memberikan hasil serabut dan pulpa yang tertinggi iaitu MK 04, MK 12, MK 13, MK 19, MK 21, MK 22, MK 23, MK 25 dan MK 28 telah dipilih untuk kajian selanjutnya di beberapa lokasi.

**Abstract**

Kenaf (*Hibiscus cannabinus* L.), a herbaceous annual plant of the Malvaceae family, is one of the important source of raw materials for the traditional production of rope, sack, canvas and carpet. A total of 16 accessions were evaluated for growth performance including leaf shape, stem pigmentation, seed size (by volume) and the phenology of each accession. Leaf shape can be classified as palmate or cordate. Stem pigmentation is either light green, dark green or reddish green and it can be distinguished among all accessions. The tallest accessions were MK 13, MK 12, MK 23 and MK 22, while MK 19, MK 13, MK 04 and MK 28 showed the largest basal stem diameter. Accessions that gave high fibre and pulp yields such as MK 04, MK 12, MK 13, MK 19, MK 21, MK 22, MK 23, MK 25 and MK 28 were chosen for further testing on fibre and pulp production at multilocations.

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## Introduction

Kenaf (*Hibiscus cannabinus* L.) is a member of Malvaceae which includes cotton and okra. It is a herbaceous short-day plant which remains vegetative until daylength reaches approximately $12^1/_2$ hours, at which point the reproductive process begins. In Malaysia, the tropical climate with 12-hour daylength may affect the vegetative growth of kenaf, and its adaptability to the local tropical environment is a major concern. Kenaf is grown basically for a vegetative product (bast and core fibre). The stem has a fibrous outer bark and a very light and strong core.

Traditionally, kenaf fibre has been used for cordage, ropes, sacks, canvas and carpets (Shamsuddin and Mahboob 1998). The commercialization of kenaf into various products has become the main focus in recent research projects since it has been chosen as one of the most promising non-wood fibres for pulp and paper production.

The purposes of this study were to evaluate 16 kenaf accessions for their adaptability to the Malaysian environment for bast fibre and pulp production, and to select the most promising accessions for further evaluation in multiple locations.

## Materials and methods

A total of 16 accessions of kenaf were directly seeded in the field in November 2001. The experimental site was at Serdang and the design was a randomized complete block design (RCBD) with three replications. The land preparation was done according to normal procedures such as mechanized blanket spraying of weedicides, ploughing, harrowing and application of basal fertilizer and rotory tilling. The plot size was 5.25 m x 5 m with a 1 m wide avenue for every four rows. The distance between rows was 25 cm and 10 cm within rows. NPK Blue Special (16:16:16:2TE) was used at a rate of 418 kg/ha, which was split into two equal applications during land preparation and at 7 weeks after planting. The morphological data as well as the growth performance of the accessions were recorded.

After 18–20 weeks of planting, kenaf was harvested to determine the fibre and core yields. Fibre yield was determined using the bacterially retted method. Ramaswamy et al. (1993) found that bacterially retted kenaf fibre has higher bundle tenacity as compared to chemically retted fibres of the same cultivar. This is important for textile production and in plastic composite applications where fibre is used to add strength or flexibility.

Ten samples were cut at about 5 cm from the ground level. Leaves and seed pods were removed and the stem length and girth were recorded. The stem bundle (20 stems per bundle) was then submerged in running water for 14–16 days. The bundle was taken out and washed to remove the slimy residual materials. The fibre was then peeled off from the core and sun-dried for a few hours before oven-dried at 70 °C for 4 days to obtain the dry weight. The fresh core weight was taken soon after peeling off the bast fibre. The remaining core was cut into pieces and oven-dried at the same temperature as for bast fibre. All the data were analysed using the Statistical Analysis System (SAS) package.

## Results and discussion

Kenaf has showy flowers and nectar that attract a number of insects which pollinate the flowers. The seed obtained are consequently not true to type which means that in some varieties, leaf shape, corolla colour and stem pigmentation may vary. Generally, the colour of the corolla is yellowish white, but is purple with a red throat (inner part of the corolla) for accession MK 04. Stem pigmentation is either light green, dark green or reddish green, and it can be distinguished among all accessions *(Table 1)*.

Accessions with cordate leaves usually had less branches and slightly hard stem, and were late in flowering whereas most accessions with palmate leaves had more

Table 1. Morphological charateristics of 16 kenaf accessions

| Accession | Origin | Leaf shape | Stem pigmentation | No. seed/g | Weeks to flowering | Germination (%) |
|---|---|---|---|---|---|---|
| MK 04 | Australia | Mix of cordate and palmate | Light green | 29 | 9 | 94.64 |
| MK 06 | Australia | Palmate | Dark green | 37 | 7 | 95.79 |
| MK 10 | Australia | Palmate | Dark green | 30 | 8 | 98.85 |
| MK 12 | Australia | Cordate | Light green | 40 | 9 | 97.58 |
| MK 13 | Australia | Cordate | Light green | 37 | 9 | 96.17 |
| MK 19 | Australia | Cordate | Light green | 38 | 7 | 95.54 |
| MK 21 | Australia | Cordate | Light green | 21 | 9 | 95.28 |
| MK 22 | Australia | Cordate | Light green | 45 | 9 | 97.32 |
| MK 23 | Australia | Palmate | Reddish green | 37 | 8 | 99.36 |
| MK 24 | Australia | Palmate | Dark green | 32 | 8 | 99.49 |
| MK 25 | USA | Palmate | Reddish to dark green | 37 | 8 | 97.07 |
| MK 26 | USA | Cordate | Light green | 29 | 7 | 95.03 |
| MK 27 | USA | Palmate | Dark green | 28 | 7 | 97.96 |
| MK 28 | Thailand | Palmate | Dark green | 34 | 7 | 97.58 |
| MK 30 | Thailand | Palmate | Dark green | 36 | 7 | 96.43 |
| MK 42 | Myanmar | Palmate | Dark green | 29 | 7 | 99.49 |

branches and harder stems, and were earlier in flowering. Accession MK 04 had both cordate and palmate leaves while the rest had only one leaf shape. The palmate leaf accessions usually have dark green stems while the cordate leaf accessions have light green stems. The reddish green stem could be observed in accessions MK 23 and MK 25. Number of seed per gramme of each accession varied from 21 (in accession MK 21) to 45 (in accession MK 22). The most appropriate time for seed collection was 7–8 weeks after flower initiation as observations showed that the viability of the seed was highest at this stage.

The germination rate of kenaf accessions was around 90–95% in each plot, and seedling emergence took at least a week. The growth was rapid at the early stage with the height reaching 180 cm within 7 weeks, but tended to be consequently slow after 11 weeks of planting. Flower initiation was as early as 7 weeks after planting especially in the palmate leaf accessions, such as MK 30, MK 19, MK 28 and some other accessions *(Table 1).* In Bangladesh, flowers are initiated within 45–56 days after planting in accessions PI 376260, EV 468077 and PI 35575151 (Shamsuddin and Mahboob 1998).

Most of the accessions reached more than 250 cm at 16 weeks after planting with a basal diameter in a range of 1.46–1.99 cm *(Table 2).* The stem fresh weight was slightly different among accessions. MK 12, MK 04 and MK 25 had the highest fresh weight but were not significantly different.

Kenaf was harvested at 18–20 weeks after planting, soon after seed collection was done. It is composed of a fibrous outer bark and a slightly hard core, making up about 35% and 65% of dry weight, respectively (Andrew and David 2000). Kenaf fibre and core yields are mainly affected by plant height, stem diameter, bark thickness, ratio of fibre to fresh stem and effective number of plants at final harvest (Li et al. 2000), but in a tropical climate the main factor is the photosensitivity of each accession. It is known that kenaf is a short-day plant.

Growth of kenaf especially for the vegetative tissue depends on daylength. In Malaysia, our daylength is only 12 hours and this may have caused early flowering of the accessions. Early flowering will restrict

Table 2. Means of plant height, basal diameter, stem fresh weight, fibre and core yields and bast ratio in 16 accessions of kenaf

| Accession | Plant height (cm) | Basal diameter (cm) | Stem fresh wt. (g) | Fibre plot yield (kg) | Fibre yield (t/ha) | Core plot yield (kg) | Core yield (t/ha) | Bast ratio* (%) |
|---|---|---|---|---|---|---|---|---|
| MK 04 | 265.50abc | 1.87ab | 372.78a | 6.28a | 2.49 | 11.26b | 4.46 | 35.79 |
| MK 06 | 255.75bc | 1.50cd | 142.22c | 2.83c | 1.12 | 11.41b | 4.52 | 19.86 |
| MK 10 | 267.27abc | 1.47d | 153.33c | 2.62c | 1.04 | 10.91b | 4.32 | 19.37 |
| MK 12 | 279.42ab | 1.48d | 370.00a | 6.38a | 2.53 | 14.78ab | 5.85 | 30.16 |
| MK 13 | 291.15a | 1.97a | 178.88c | 4.51b | 1.79 | 15.83ab | 6.27 | 22.16 |
| MK 19 | 252.76bc | 1.99a | 117.44c | 2.83c | 1.12 | 15.17ab | 6.01 | 15.73 |
| MK 21 | 257.84bc | 1.61bdc | 120.55c | 3.78b | 1.50 | 10.47b | 4.15 | 26.51 |
| MK 22 | 277.36ab | 1.59bdc | 138.89c | 4.37b | 1.73 | 19.00a | 7.52 | 18.71 |
| MK 23 | 278.16ab | 1.62bdc | 203.89bc | 4.52b | 1.79 | 12.12b | 4.80 | 27.16 |
| MK 24 | 243.95c | 1.48cd | 179.78c | 2.70c | 1.07 | 15.36ab | 6.08 | 14.95 |
| MK 25 | 260.36bc | 1.72abcd | 308.46ab | 3.50bc | 1.39 | 9.80b | 3.88 | 26.35 |
| MK 26 | 243.73c | 1.48d | 132.22c | 2.65c | 1.05 | 11.76b | 4.66 | 18.41 |
| MK 27 | 263.58abc | 1.50cd | 130.00c | 2.51c | 0.99 | 10.04b | 3.96 | 20.00 |
| MK 28 | 264.62abc | 1.82abc | 142.77c | 2.94c | 1.16 | 10.93b | 4.33 | 21.21 |
| MK 30 | 254.27bc | 1.62bcd | 217.22bc | 2.97bc | 1.18 | 14.40ab | 5.70 | 17.11 |
| MK 42 | 245.93c | 1.46d | 129.77c | 2.59c | 1.03 | 10.96b | 4.34 | 19.13 |

*Bast ratio = Ratio of dry fibre to dry core

Values within a column with common letters are not significantly different from one another at 5% level of probability

Table 3. Correlation coefficients between height, girth, fibre yield, core yield and weeks to flowering

| | Height | Girth | Fibre yield | Core yield |
|---|---|---|---|---|
| Girth | 0.35<br>(0.015*) | | | |
| Fibre yield | 0.62<br>(<0.001***) | 0.29<br>(0.05*) | | |
| Core yield | 0.30<br>(0.04*) | 0.11<br>(0.46 ns) | 0.33<br>(0.02*) | |
| Weeks to flowering | 0.46<br>(0.0009***) | 0.14<br>(0.35 ns) | 0.70<br>(<0.0001***) | 0.20<br>(0.17 ns) |

Figures in brackets denote the level of statistical significance

*Plate 1. MK 04, a promising accession for kenaf fibre production*

vegetative growth because all the energy and proteins will be allocated to reproductive growth such as seed development. Statistical analysis *(Table 3)* revealed that there were very significant correlations between fibre yield and height, fibre yield and weeks to flowering, and between height and weeks to flowering. Early flowering in some accessions may contribute to the low yield of fibre and also short stem length.

In this study, the tallest accessions were MK 13, MK 12, MK 23 and MK 22, while MK 19, MK 13, MK 04 and MK 28 had the largest basal stem diameter. Accessions MK 12, MK 04 *(Plate 1),* MK 23, MK 13 and MK 22 gave high bast fibre yields, ranging from 1.73–2.53 t/ha, while the rest of accessions gave lower yields ranging from 0.99–1.50 t/ha.

The bast fibre yields in this study were comparable to those recorded in China, Thailand and Indonesia. In China, the high fibre yielding accession is BG 52–135 which produces 2.55 t/ha (Su et al. 1998). The accession had undergone trials at multiple locations but the yield data were not published. In Thailand, the highest bast fibre yields recorded are 2.10 t/ha and 2.19 t/ha from accessions DS/012/H and X/029/H, respectively (Werapon 1998), while in Indonesia accessions KK60 and Tha/NY/012H were reported to have 15% more bast fibre yield (Sudjindro et al. 1998) as compared to check variety (2.5 t/ha).

As for core yield, MK 22, MK 13, MK 24, MK 19 and MK 12 ranked highest compared to the other accessions. The highest core yield was 7.52 t/ha (from accession MK 22) while core yields from the other accesions ranged from 3.9–6.3 t/ha. These core yields were relatively lower than those reported in Thailand which are 16.46 t/ha for accession SM/048/H and 15.71 t/ha for DS/028/H (Werapon 1998).

To get a better yield, the vegetative growth factors such as fertilizer application, weed control, varietal selection for non-photosensitivity and bast ratio have to be manipulated. Bast ratio is the ratio of dry fibre to dry core per plant, and can be directly manipulated by plant population. The ratio increases as the plant population increases, most likely because of competition for nutrients and sunlight, which leads to spindly growth and therefore longer fibres. In addition, kenaf also needs to be planted at an appropriate time of the year which has not been determined yet. It requires an adequate water supply during the early stage of planting, but water has to be reduced at a later stage to avoid diseases such as Phytophthora which can spread through surface run-off.

## Conclusion

This preliminary study of 16 accessions showed that the accessions that gave high bast fibre and core yields and/or high bast ratios were MK 04, MK 12, MK 13, MK 19, MK 21, MK 22, MK 23, MK 25 and MK 28. These selected accessions will be further evaluated for their fibre and core production at multiple locations.

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