# Variability Studies in Kokam (*Garcinia indica*)

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The variability in kokam [*Garcinia indica* (Thouars) Choisy] available in the NBPGR Regional Station, Vellanikkara, Thrissur, Kerala, India was analysed. Major objectives of the study were to explore and document the variability in vegetative, floral and fruiting characters of *G. indica*. This study clearly indicated the existence of variability among the accessions/trees being maintained in the field genebank. Three accessions were found to be promising for separate characters such as IC 136687-3 for individual fruit weight, IC 136687-2 for total yield/tree/year and IC 136685-1 for number of fruits/tree/year.

**Key Words: *Diversity, Garcinia indica,* Germplasm, Kokam, Variability**

Kokam is one of the potential under-exploited multipurpose crops, currently gaining much commercial and medicinal importance. Botanically Kokam [*Garcinia indica* (Thouars) Choisy] belongs to the family Clusiaceae, formerly known as Guttiferae. It is endemic to the Western Ghats region in Maharashtra, Goa, and Karnataka but rare in Kerala and TamilNadu (Singh, 1993). Its fruits are valued for its nutritional and medicinal properties (Hadankur *et al.*, 1987). The dried rind is used as an excellent substitute for tamarind and lime, in the preparation of non-vegetarian curries especially for fish for imparting a special flavour and taste. It is used in preparing syrup during summer in Goa and Karnataka. Pharmaceutically active ingredient, (-)-hydroxycitric acid (HCA) which accelerates fat burning and inhibits fatty acid synthesis has been reported to occur in fruit rind (Krishnamurthy *et al.*, 1982; Akhtar Husain *et al.*, 1992). The seeds yield valuable fat known as kokam butter, which is edible and suitable as ointment in medicinal preparations for fissures of lips and heel (Singh, 1993).

It is a cross-pollinated and heterozygous crop. South Maharashtra and Goa regions is the centre of origin of this crop. Limited plantations are available in South Maharashtra and Karnataka. However, the bulk of the raw material is derived from wild sources. Due to severe deforestation and habitat destruction, genetic erosion is taking place and so there is a need for its conservation. There are no studies on variability in this crop. Hence, variability of kokam available at NBPGR Regional Station, Thrissur, was studied, where this crop has been introduced from North and South Kanara districts of Karnataka as seedling progenies.

## Materials and Methods

Three-year-old 10 seedlings collected from North Kanara and one from South Kanara district of Karnataka were transplanted during the year 1992 at NBPGR Regional Station's farm at Vellanikkara, Thrissur (Table 1). On the day of observation trees were 8-11 years old. Observations on vegetative characters such as tree height (cm), tree spread (cm), leaf length (cm), leaf breadth (cm), leaf area ($cm^2$), petiole length (cm) and branching nature were recorded. Flower characters such as number of stamens, number of bundles, number of anthers per bundle and percentage of lightly stained pollen grains, deeply stained pollen grains, flowering season and fruiting season were recorded. Fruit characters such as weight (g), fresh rind weight (g), fresh rind thickness (mm), fresh fruit height (mm), fresh fruit diameter (mm), seed number, seed weight (g), seed length (mm), seed width (mm), seed thickness (mm), and pulp weight (g) were recorded. Yield related characters such as year of transplanting, first year of flowering, yield in kg/tree/year and number of fruits/tree/year were recorded. Leaf area was calculated by the method suggested by Lila Mathew *et al.* (1996). A mean of 10 observations on vegetative and fruit characters, five on flower characters, four yearly observations in flowering and bearing characters were subjected to statistical analysis.

## Results and Discussion

Among the 10 trees, five were male, four female and one bisexual (Table 2). Data recorded on male, female and bisexual trees (Table 1) revealed, significant variations, the tree height ranged from 480 to 600 cm in male trees, 528 to 612 cm in female trees and the bisexual tree recorded 552 cm. The tree spread varied from 360 to 672 cm in male, 248-720 cm in female and 456 cm in bisexual tree. Significant variations were observed in leaf length and leaf breadth for female, male and bisexual. The trees studied were with both horizontal and drooping branches. Trees with horizontal

**Table 1. Variation in vegetative characters of different kokam genotypes**

| Acc. No. | Tree height (cm) | Tree spread (cm) | Leaf length (cm) | Leaf breadth (cm) | Leaf area ($cm^3$) | Petiole length (cm) | Branching nature |
|---|---|---|---|---|---|---|---|
| IC 136682-2 | 593 | 492 | 6.46 | 2.42 | 15.32 | 0.56 | Horizontal |
| IC 136685-1 | 612 | 444 | 7.22 | 3.30 | 23.05 | 0.75 | Drooping |
| IC 136687-1 | 552 | 456 | 7.37 | 3.19 | 22.72 | 0.70 | Horizontal |
| IC 136687-2 | 556 | 248 | 6.69 | 2.84 | 18.50 | 0.89 | Drooping |
| IC 136687-3 | 528 | 720 | 5.96 | 2.70 | 15.75 | 0.73 | Horizontal |
| IC 136684-3 | 504 | 456 | 7.67 | 3.24 | 25.53 | 1.03 | Horizontal |
| IC 136685-2 | 456 | 576 | 6.08 | 3.19 | 20.15 | 0.73 | Horizontal |
| IC 136685-3 | 480 | 432 | 6.54 | 2.51 | 17.21 | 0.60 | Horizontal |
| IC 136682-3 | 485 | 360 | 6.94 | 2.67 | 19.30 | 0.63 | Horizontal |
| IC 136678 | 600 | 672 | 8.37 | 3.77 | 32.15 | 0.99 | Horizontal |
| SE | 17.32** | 44.28** | 0.23 | 0.13 | 1.62 | 0.05 | |

** Significant at 1% level

branches occupied larger area with fewer yields but trees with drooping branches were promising as the spacing requirements per tree is less. A total of 80% of the trees had horizontal branches, that is all the male trees, two female trees and one bisexual tree recorded horizontal branches and only two female trees recorded the drooping branches.

Regarding female and bisexual trees, flower characters (Table 2) variability was noticed in terms of number of staminodes, there was no variability in terms of number of bundles (4) in both female and bisexual trees studied. Only a limited amount of variability was noticed among the collections in terms of number of staminodes/bundle 8 to 9 and 8.8 for female and bisexual, respectively. The male trees recorded 5 months of flowering period between December to April. The fruiting period in female trees was from January to May.

The physical parameters of fruit (Table 3) varied in respect to fresh fruit weight, fresh rind weight, fresh rind thickness and fruit diameter in female and bisexual trees. The same trend of variation, in female trees and the least value in bisexual trees was recorded in the following seed characters. In contrast, the thickest seed (8.16 mm) was observed in bisexual tree whereas female trees recorded the range from 5.67 to 6.11 mm. The best genotype with respect to fruit weight was IC 136687-3.

In respect of yield characters (Table-4), all the trees came to flowering at the age of eight years except IC 136687-3 which came at the age of nine. Bearing progressed from 1997 to 1999 gradually under minimal cultural practices with farmyard manure (FYM). FYM was applied @ 21 kg/tree/year during 1996-97, 1998-99 and 1999-2000. Because of application of NPK mixture (8:8:16) @ 200 g/tree/year during 1998-99 and NPK mixture (17:17:17) @ 400 g/tree/year during 1999-2000, there was increase in yield in all to the extent of 2 to 21 times during 1999-2000. Among the available data in all the bearing years, the accession IC 136687-2 was found to be the best which recorded 28.77 kg/tree/year. Regarding the number of fruits, the similar trend as to that of yield was followed for fertilizer application. The more number of fruits were recorded in the accession IC 136685-1 which recorded

**Table 2. Variation of flower characters of different kokam genotypes**

| Acc. No. | No. of Staminodes/ Stamens | No. of bundles | No. of staminodes per bundle | Lightly stained pollen grains (%) | Deeply stained pollen grains (%) | Flowering Season | Fruiting season | Sex |
|---|---|---|---|---|---|---|---|---|
| IC 136682-2 | 06-17 | 4.00 | 08.80 | 100 | - | Jan-Feb | Jan-May | F |
| IC 136685-1 | 05-12 | 4.00 | 09.20 | 99.28 | - | Jan-Feb | Jan-May | F |
| IC 136687-1 | 06-10 | 4.00 | 08.80 | 99.47 | - | Jan-Mar | Mar-May | B |
| IC 136687-2 | 06-08 | 4.00 | 08.00 | 98.94 | - | Jan-Feb | Jan-May | F |
| IC 136687-3 | 06-12 | 4.00 | 09.60 | 100 | - | Jan-Feb | Jan-April | F |
| IC 136685-2 | 37-44 | 1.00 | 40.60 | - | 92.3 | Dec-April | - | M |
| IC 136678 | 34-44 | 1.00 | 39.40 | - | 94.48 | Jan-Mar | - | M |
| IC 136684-3 | 23-38 | 1.00 | 30.56 | - | 91.08 | Jan-April | - | M |
| IC 136685-3 | 23.36 | 1.00 | 29.20 | - | 83.17 | Jan-April | - | M |
| IC 136682-3 | * | * | * | * | * | Jan-April | - | M |
| SE± | 4.75 | 0.57 | 04.71 | | NS | - | - | |

* Data not available

**Table 3. Variation in physical parameters of fruits from different kokam genotypes**

| Acc. No. | Fresh Fruit weight (g) | Fresh rind weight t (g) | Fresh rind thickness (mm) | Fruit height (mm) | Fruit diameter (mm) | Pulp weight (g) | Seed number | seed weight (g) | Seed length (mm) | Seed breadth (mm) | Seed thickness (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IC 136682-2 | 18.53 | 07.96 | 2.52 | 30.04 | 33.88 | 07.29 | 5.10 | 3.28 | 17.12 | 09.31 | 6.07 |
| IC 136685-1 | 17.17 | 08.17 | 2.63 | 26.41 | 33.96 | 06.26 | 5.60 | 2.73 | 12.84 | 08.93 | 5.67 |
| IC 136687-1 | 06.18 | 03.11 | 1.89 | 22.87 | 22.07 | 04.22 | 1.00 | 1.96 | 14.89 | 08.65 | 8.16 |
| IC 136687-2 | 15.54 | 06.91 | 2.42 | 25.91 | 32.75 | 05.39 | 4.40 | 2.47 | 15.84 | 09.77 | 6.11 |
| IC 136687-3 | 25.16 | 10.73 | 2.41 | 32.98 | 37.33 | 10.72 | 5.40 | 3.70 | 17.35 | 10.70 | 6.06 |
| SE± | 07.86** | 03.18 | 0.33 | 04.51** | 06.68** | 02.24 | 2.19 | 0.78 | 02.12 | 00.93 | 1.14 |

** Significant at 1% level

**Table 4. Variation in yield characters of different kokam genotypes**

| Acc. No. | Year of transplanting | Year of first Flowering | Yield kg/tree year | | | | Number of fruits/tree/year | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1997 | 1998 | 1999 | 2000 | 1997 | 1998 | 1999 | 2000 |
| IC 136682-2 | 1992 | 1997 | 0.025 | 2.041 | 4.005 | 19.165 | 1.00 | 139 | 321 | 2,260 |
| IC 136685-1 | 1992 | 1997 | 0.000 | 2.705 | 8.956 | 19.905 | 4.00 | 179 | 827 | 3,268 |
| IC 136687-1 | 1992 | 1997 | 0.033 | 0.000 | 0.000 | 00.025 | 1.00 | 000 | 000 | 0,004 |
| IC 136687-2 | 1992 | 1997 | 0.000 | 2.791 | 9.218 | 28.766 | 6.00 | 123 | 409 | 2,209 |
| IC 136687-3 | 1992 | 1998 | 0.000 | 0.009 | 1.221 | 26.012 | 0.00 | 001 | 066 | 1,954 |
| SE± | | | 0.007 | 0.630 | 1.910 | 05.030 | 1.12 | 37.03 | 146.93 | 533.23 |

3,268 fruits/tree/year. The accession, which recorded higher number of fruits, gave low yield and *vice versa* this is because of natural adjustment and energy diversion (Muthulakshmi, 1998).

In general, compared to the morphological characters of the fruit, variations observed in flower characters were limited. While demarcating the lines with higher yield and good quality, it was not possible to select kokam accessions with all the characters i.e., high fruit weight, number of fruits, rind thickness, pulp weight, seed number, seed length, breadth and thickness. However, accessions with individual quality characters could be identified which can be utilized for further improvement. The present study indicated the existence of variability among the accessions in terms of vegetative, floral, fruit and yield characters and the existence of distinct male, female and bisexual trees. There is a need for identifying the sex of the plants in the seedling stage itself as is being done in Malabar tamarind (Muthulakshmi, 1998). Since, soft wood grafting in kokam has been found successful (Hadankur *et al.*, 1987), sex determination could be used for large scale multiplication of elite trees. Rapid multiplication needs to be attempted through *in vitro* technology for popularising true-to-type plantations of high yielding lines. Moreover, fruit bearing coincides with summer months which is ideal for drying the rind. Any success in transferring this trait to malabar tamarind (*G. gummigutta*), would be highly useful for the farming community of this locality for rind drying, as it bears fruits during the rainy season.

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