

Karyotype studies in *Mucuna macrocarpa* Wall and *Mucuna sanjappae* Aitawade et Yadav (Fabaceae) from India

S. V. Gaikwad¹, R. V. Gurav and S. R. Yadav

Department of Botany, Shivaji University, Kolhapur 416004, India

¹Author for correspondence: (gswaroop20@gmail.com)

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ABSTRACT: The genus *Mucuna* Adans. is represented by 100 species distributed in the world tropics (Lackey 1981; Mabberley 2005). India is one of the natural center of origin of *Mucuna*. Up to now there are 11 species and three varieties of *Mucuna* reported in India. *Mucuna pruriens* is useful for medicinally where as *Mucuna pruriens* var. *utilis* used for food and fodder purpose (Janardhanan and Lakshmanan 1985; Pugalenti *et al.* 2005). *Mucuna sanjappae* is one of the important medicinal plants since it contains high amount of L-dopamine, which significantly proved as antiparkinson's drug (Patil *et al.* 2015). *Mucuna macrocarpa* is also medicinally important because of its antileukemic effects on human leukemic cells (Kaun-Hung *et al.* 2012). For the characterization and identification of the proper species the chromosome studies are utmost important. The present work is the first report on karyomorphological analysis of two species of Indian *Mucuna* viz. *M. sanjappae* which is endemic to northern Western Ghats, Maharashtra and *Mucuna macrocarpa* from North-East India. Both the species represented by the chromosome number of $2n = 22$. The karyotype formula for *M. sanjappae* is 11m, while that for *M. macrocarpa* is 10m + 1M. Total chromosome length in *M. sanjappae* is 25.15µm while that in *M. macrocarpa* it is 25.58 µm. Both the species show highly symmetrical karyotype *i.e.* (1a).

KEYWORDS: *Mucuna sanjappae*, *Mucuna macrocarpa*, Karyotype, India.

The genus *Mucuna* is represented by 11 species and three varieties from India. Recently *Mucuna laticifera* which is newly described from Sikkim, northeastern India by Ingalthalikar *et al.* (2017). The genus was revised by Wilmot-Dear (1987) from Indian subcontinent and Burma which yielded nine species of *Mucuna*. The genus is of great importance because of its medicinal value *i.e.* it contains some antiparkinson's drugs. It has been used as a source of food and as a soil improving and pasture crop (Duggar 1899). *Mucuna* species come from China and Eastern India where it is widely cultivated as green manure (Burkill 1966; Duke 1981 and Wilmot-Dear 1984). *Mucuna sanjappae* newly discovered by Aitawade and Yadav (2012) is endemic to North Western Ghats of India. Habitat of *Mucuna sanjappae* is different from that of the other *Mucuna* species, it is found on hilly area, where as the remaining *Mucuna* found near water bodies. It is perennial, woody climber, 4-5 cm in diameter and 15-20 m long, leaves are pinnately trifoliolate. Their inflorescence is 40-42 cm long, flowers are dark purple in color. Pods are slightly curved and golden brown in color, seeds are black in colour and blotched, and ellipsoid in shape. *Mucuna macrocarpa* is found in north-east India, It grows on high altitude, it is also perennial woody climber, up to 60 m long, stem 25 cm in diameter, leaves trifoliolate, inflorescences 30-40 cm long, corolla purple, standard green. Pods are 30-40 cm long, seeds are black in color, hilum encompassing more than half of the seed circumference. After reviewing available literature on cytological studies of *Mucuna* it has been revealed that these two species have escaped from the attention of earlier workers. Hence in present study an attempt has been made to study the cytological details in these two

species.

MATERIALS AND METHODS

Seeds of *M. sanjappae* were collected from Junner, Maharashtra from North western ghats while those of *M. macrocarpa* were collected from Darjeeling, West Bengal, North east India. They were planted and grown in the Botanical Garden, Department of Botany, Shivaji University at Kolhapur. Seeds of *M. sanjappae* were mechanically scarified by rubbing on rough surface and then soaked in lukewarm-water for 24 hrs. Then, those seeds were washed with distilled water and sown for germination in cocopeat tray. In *M. macrocarpa* seed coat are very hard, for their scarification seeds were soaked in conc. H₂SO₄ for 5 minutes. Then seeds were washed with distilled water and sown in cocopeat tray. For mitotic studies the root tips obtained were used after pre-treatment with aqueous solution of 2-4-paradichlorobenzene (PDB) at 8 -10⁰ C for 5-6 hrs. These root tip were hydrolysed in 1N HCl, stained and squashed with 2% propionic orcein. Photography of well separated chromosome cell plate was done on Carl Zeiss axio imager A2 microscope with attached camera at 1000x magnification. The karyotype was described by following the nomenclature of Levan *et al.* (1964). The degree of Karyotype symmetry has been determined as per categories of Stebbins (1958).

RESULTS AND DISCUSSION

Karyotypes with analytical data of *Mucuna sanjappae* and *M. macrocarpa* were presented in Tables 1, 2 and 3 and Fig. 1 with detailed chromosome size, average chromosome size and chromosome counts. Karyotype formulae were categorized on the basis of chromosome size.

Table 1. Cytological charactres and location of *Mucuna* species

Sr.no	Taxon	Karyotypic formula	Stebbins-Asymmetry classes	Distribution	Latitude and Longitude
1	<i>Mucuna sanjappae</i>	11m	1a	Maharashtra, Junner.	N.27 ⁰ .02.111 E .88 ⁰ .16.052
2	<i>Mucuna macrocarpa</i>	10m + 1M	1a	West – Bengal Darjeeling	N.19 ⁰ .18.465 E.74 ⁰ .01.155

Mucuna sanjappae and *M. macrocarpa* showed the somatic chromosome number $2n = 22$. Mean chromosome length in *M. sanjappae* was 2.32 μm where as in *M. macrocarpa* it is 2.29 μm . Total chromosomal length was

more or less similar i.e. 25.58 μm in *M. macrocarpa* and 25.29 μm in *M. sanjappae*. While, A1 and A2 indices were more or less similar to each other in both the species.

The karyotypic formula of *M. macrocarpa* was $K =$

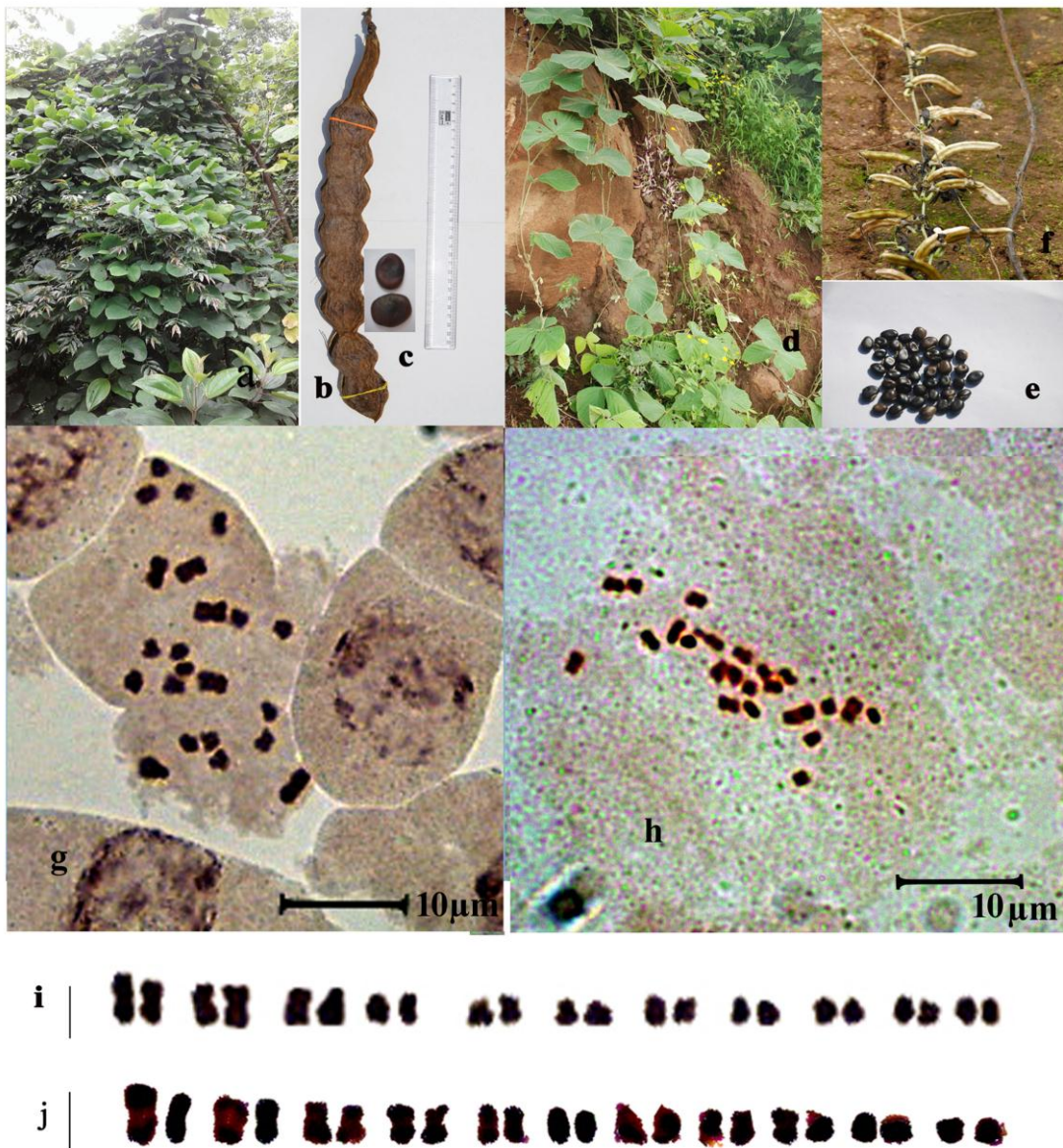


Fig. 1. *Mucuna macrocarpa* Wall (a,b,c,g,i) and *Mucuna sanjappae* Aitawade et S. R. Yadav (d,e,f,h,j). a, d: Habit; b, f: Pod; c, e: Seeds; g, h: Mitotic metaphase showing 22 chromosomes; I, j: Karyogram (scale bars show 2.73 μm).

Table 2. Karyological analysis of *Mucuna macrocarpa*

Chromosome pair	Length of long arm (l) (μm)	Length of short arm (s) (μm)	Total length (μm) $c = l+s$	Arm ratio $R = l/s$	Centromeric index $I = s/c \times 100$	Centromeric position
1	1.76 \pm 0.22	1.46 \pm 0.36	3.23 \pm 0.58	1.20	45.31	m
2	1.59 \pm 0.44	1.25 \pm 0.32	2.85 \pm 0.75	1.27	44.02	m
3	1.45 \pm 0.29	1.19 \pm 0.24	2.65 \pm 0.51	1.22	45.02	m
4	1.43 \pm 0.14	1.05 \pm 0.15	2.48 \pm 0.27	1.35	42.47	m
5	1.27 \pm 0.20	1.06 \pm 0.09	2.33 \pm 0.25	1.20	45.36	m
6	1.32 \pm 0.31	0.98 \pm 0.21	2.30 \pm 0.46	1.34	42.70	m
7	1.19 \pm 0.27	0.95 \pm 0.21	2.15 \pm 0.41	1.25	44.41	m
8	1.01 \pm 0.14	0.93 \pm 0.15	1.94 \pm 0.09	1.09	47.78	M
9	1.04 \pm 0.15	0.93 \pm 0.1	1.97 \pm 0.30	1.11	47.33	m
10	0.99 \pm 0.05	0.79 \pm 0.11	1.79 \pm 0.09	1.26	44.23	m
11	1.00 \pm 0.21	0.84 \pm 0.25	1.84 \pm 0.46	1.18	45.71	m

10m + 1M and that of *M. sanjappae* was K = 11m. Both the species in the karyotype were highly symmetrical showing karyotype symmetry 1a.

Mucuna is placed in the Subtribe Erythrinae of the Tribe Phaseoleae of the family Fabaceae by Lackey (1980). The chromosome base number of *Mucuna* is X = 11 (Bairiganjan and Patnaik 1989) which is same as that of Indian *Mucuna* species except *M. gigantea* and *M. bennetti* (Sastrapradja *et al.* 1974) reported the basic number of X = 14. Low % polyploidy (18%) was found in the family Fabaceae (Goldblatt 1981). *Mucuna* has very low % of polyploidy. Earlier workers reported diploid chromosome number of $2n = 22$ in *M. pruriens*, (Bairiganjan and Patnaik 1989), *M. monosperma* (Thuvan 1975), in *M. atropurpurea* (Jaheer and Sathyanarayana 2010) and *M. nigricans* (Kumari and Bir 1990) and in our present cytological investigation for diploid chromosome number of *M. sanjappae* and *M. macrocarpa* $2n = 22$ was observed. For the determination of the THCL of papilionaceous legume the chromosome size is more important and is the real determinant rather than chromosome number (Kumari and Bir 1985, 1989).

In earlier study (Kumari and Bir 1990) showed that the total chromosome length in *M. pruriens* was 16.38 μm and that in *M. nigricans* was 16.86 μm , and their mean chromosomal lengths were 1.48 μm and 1.53 μm , respectively. Additionally, the chromosome size in *M. pruriens* ranged from 0.80 to 2.11 μm and those in *M. nigricans* ranged from 1.01 μm to 2.59 μm . Total chromosome length in *M. sanjappae* was 25.15 μm and that in *M. macrocarpa* was 25.58 μm . Chromosome size range in *M. sanjappae* was 1.71 - 3.03 μm and that in *M. macrocarpa* was 1.84 - 3.23 μm , which is nearly equal to other species. Karyotypes analysed on the basis of

Stebbins (1958) categorization indicated that 2b category in the Fabaceae followed by 1a, 2a, and 1b types their by showing large symmetrical nature (Kumari and Bir 1989). During the course of the present study the data showed that both the species of *Mucuna* i.e. *M. sanjappae* and *M. macrocarpa* categorise in to 1a showing highly symmetrical karyotype. These cytomorphological studies are helpful for improving the character by hybridization to utilise seeds for food and medicinal purpose.

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Table 3. Karyological analysis of *Mucuna sanjappae*

Chromosome pair	Length of long arm (l) (µm)	Length of short arm (s) (µm)	Total length (µm) c = l+s	Arm ratio R = l/s	Centromeric index I = s/c x100	Centromeric position
1	1.68±0.23	1.34±0.20	3.03±0.40	1.25	44.37	m
2	1.44±0.22	1.21±0.22	2.65±0.40	1.19	45.75	m
3	1.44±0.18	1.13±0.23	2.57±0.41	1.28	43.84	m
4	1.30±0.29	1.12±0.27	2.42±0.44	1.15	46.43	m
5	1.30±0.27	1.01±0.11	2.30±0.36	1.29	43.75	m
6	1.25±0.14	1.03±0.18	2.28±0.32	1.21	45.26	m
7	1.18±0.19	1.01±0.14	2.19±0.32	1.17	46.05	m
8	1.22±0.27	0.91±0.14	2.14±0.36	1.34	42.70	m
9	1.20±0.17	0.78±0.24	1.98±0.36	1.54	39.32	m
10	1.01±0.11	0.86±0.21	1.87±0.31	1.17	46.15	m
11	0.96±0.08	0.75±0.24	1.71±0.24	1.27	43.98	m

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