Morphological and phytochemical variability of different accessions of *Gmelina arborea*

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Abstract: *An attempt was made to analyse the variability and correlation of characters among five accessions of Gmelina arborea collected from different geographical and agroclimatic regions of South India. All the five accessions showed different levels of morphological and phytochemical variability. Leaf area showed maximum morphological variability. Phytochemical analysis using HPLC revealed quantitative variation of chemical constituents. Among the morphometric characters studied, leaf length, leaf breadth, leaf area and petiole length showed significant positive correlation towards each other. Results of this study will be of use in commercial exploitation and breeding activities of this valuable medicinal tree.*

Key words: *Gmelina arborea*, morphological variability, phytochemical variability

INTRODUCTION

Gmelina arborea (Roxb.) belonging to the family Verbenaceae is distributed naturally in 11 countries in tropical and subtropical regions of Asia. In India, it is found in the eastern sub-Himalayan tract, the Indo-gangetic plains, the Aravalai Hills, central India, the western peninsula and the western Himalayas (Fig. 1). It contributes substantially to timber and fodder production and is used in traditional medicine and is grown extensively both on government and private lands of India. The potential of the plant, its distribution, botany, silviculture, management, wood properties and utilization have been studied by earlier workers (Das, 1970; Dvorak, 2004). The vast distribution range of *G. arborea* in India from 8° to 27° N and 72° to 96° E, should have given rise to significant genetic variation (Lauridsen 1977). The possibility of tree selection and breeding for genetic improvement of *Gmelina arborea* has also been reported by earlier workers like Tewari (1995) and Indira (1995, 2006). The present study is an effort to analyze the variability of *Gmelina arborea* genotypes present in the different geographical and agroclimatic regions of two southern states of India at morphological and phytochemical level and also to find out the interrelationship of characters by correlation analysis.

MATERIALS AND METHODS

The Plant Material

The study includes observations on morphological and phytochemical differences between the different accessions that are being maintained in the medicinal plants germplasm of Centre for Medicinal Plants Research (CMPR), Arya Vaidya Sala, Kottakkal, Kerala, India so as to assess the variation between them. The accessions have been collected from the states of Kerala, Karnataka and Tamil Nadu (Table 1) and maintained *ex situ* under natural farm conditions with organic manuring and plant protection measures. Experimental observations were carried out from September 2003 to February 2005 at CMPR.

Table. 1. Details of the accessions of *Gmelina arborea* studied

Accession No.	Place of collection
GA 01	Muniyal Herbs & Ayurvedic Remedies, Manipal, Karnataka
GA 02	Kerala Agriculture University Research Station, Odakali, Ernakulam, Kerala
GA 03	Bird-K, Tumkur, Karnataka
GA 04	Manimala, Wayanad, Kerala
GA 05	Nagarjuna Herbals, Idukki, Kerala
GA 06	Sirumali, Dindigul, Tamil Nadu
GA 07	Amasapuram, Theni, Tamil Nadu
GA 08	Herbal garden, AVS, Kottakkal, Kerala
GA 09	Estate(AVS), Anoli, Malappuram, Kerala
GA 10	Estate (AVS), Peruvangad, Malappuram, Kerala

Fig. 1. *Gmelina arborea*

Study of Morphological Variability

Variability among the accessions in the case of different morphological characters (Table 2) was analyzed with the help of mean, range, standard deviation (SD), standard error (SE) and coefficient of variation (CV) (Khan, 2000).

Table 2. Morphological variations in quantitative characters in the case of *Gmelina arborea*

Sl. No.	Characters	Mean	SE	Range	SD	CV
1	Leaf length(cm)	13.57	0.83	11.5-18.5	2.65	19.52
2	Leaf breadth (cm)	11.14	0.85	8.7- 16.2	2.70	24.23
3	LL / LB	1.22	0.01	1.14- 1.3	0.06	4.91
4	Leaf area (cm^2)	45.82	15.98	71.64-209.79	50.52	45.82
5	Petiole length (cm)	11.15	0.33	10.1- 12.7	1.06	9.50
6	Stabilized internodal length	26.21	1.60	8.0- 26.0	5.06	26.21

Study of Phytochemical variability

The accessions from different geographical and agroclimatic regions maintained in the germplasm were subjected to analysis of phytochemical variability using HPLC method. Leaves with some shoot parts were used as samples for phytochemical analysis. The samples were dried in shade, powdered and 10g each of the dried samples were reflux condensed using methanol (3 x 100ml) for 8 hours at 50^{O}C. The extracts were filtered and concentrated under reduced pressure in a rotary evaporator below 50^{o}C. 10 mg each of the concentrated extracts were dissolved in 10 ml methanol and used for HPLC analysis.

The Shimadzu HPLC system consisting of LC-10ATVP pump, a rheodyne injector, SPD M10AVP photodiode array detector and CLASS-VP 6.12 SP5 integration software was used for the analysis. The stationary phase was Phenomenex Luna C 18 (250 x 4.6 mm) column with 5µ particle size and a guard column. The mobile phase was passed through 0.45µ PVDF filter, degassed and used. The column was equilibrated with the mobile phase for one hour and then pumped with a back pressure of 200 kg/cm^2. The injection volume was

20µl and the chromatograms were run for 20– 40 min under the mobile phase of MeOH (100%). The chromatographic patterns of the various accessions were compared and paired affinity indices (PAI) were computed. The PAI between A and B is calculated as follows:

$$PAI = \frac{\text{Number of peaks similar to A \& B} \times 100}{\text{Number of similar peaks + number of dissimilar peaks in A \& B}}$$

where A and B stand for any two accessions (Ravindran *et al*., 1992). PAI is a measure of chemical affinity between any two accessions.

Correlation of characters

Correlation analysis is used to analyze interrelationships between characters. Correlation of the characters has been worked out using correlation coefficient and its significance using *t* test (Rangaswamy, 1995).

RESULTS AND DISCUSSION

Morphological variability

Study of variability of quantitative morphological characters based on eight parameters revealed maximum variability in the case of leaf area (Table.2). Morphological variability of characters shows the genotypic differences between the different accessions of the species studied. It can be used as an index to analyze the genotypic differences present within the species and such differences indicate the genetic diversity of the species that has accumulated in the course of evolution of the species in different populations. Such diversities, since they have originated in different habitats and have contributed significantly towards the adaptability and divergence of the species, can be considered as valuable sources of genes and genotypes for the selection of superior accessions leading to their use in conservation, propagation and their commercial exploitation. Similar studies have been carried out in medicinal plants by earlier workers (Misra *et al*., 1998, Raghu, 2006), rice (Shobha, 1993), tea (Ramasubramanian, 2005), coffee (Nikhila *et al*., 2002; Raghu *et al*., 2003), cardamom (Radhakrishnan *et al*., 2005), Coriander (Srivastava *et al*., 2000) and such studies have helped in the identification of superior genotypes of the corresponding plants.

Phytochemical variability

The number of peaks appeared in the HPLC chromatogram (Fig. 2) in each species were arranged pattern wise to study the paired affinity index (PAI) (Table 3). Almost identical Rt values were checked by spectrum analysis and classified on its basis. Among the accessions taken for the study, accession from Sirumalai, Dindigul, Tamil Nadu (GA 06) showed high chemical affinity (20.58%) with accession from Herbal Garden, AVS, Kerala (GA 08). Accession from Amasapuram, Theni, Tamil Nadu (GA 07) and Sirumalai, Dindigul, Tamil Nadu (GA 06) showed the lowest affinity (7.81%) among the accessions.

Fig. 2. HPLC chromatogram of 5 accessions of *Gmelina arborea*

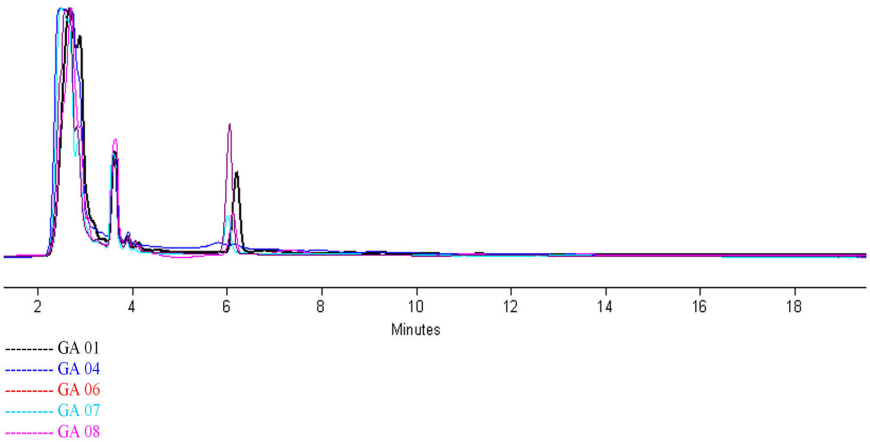

Table 3. Paired affinity index (PAI) of the different accessions *Gmelina arborea*

Accessions	GA 01	GA 04	GA 06	GA 07	GA 08
GA 01	100				
GA 04	17.03	100			
GA 06	15.38	16.21	100		
GA 07	9.52	18.96	7.81	100	
GA 08	14.28	9.52	20.58	18.91	100

Phytochemical characters are the indicators of the chemical constituents of plants and the study of phytochemical variation is very important in medicinal plants since medicinal property of any plant is the result of the action of such chemicals. Analysis of the phytochemical variability between accessions in the case of medicinal plants will help to identify them in terms of their differences in phytochemical constitution. Moreover, phytochemical differences are good indicators of their genotypic distances. Studies on phytochemical variability have been attempted by early workers in different crops like cinnamon (Ravindran *et al*., 1992), pepper (Ravindran and Nirmal Babu, 1994), tea (Ramasubramanian, 2005) and medicinal plants (Raghu *et al.*, 2007).

Correlation of characters

Biological characters are controlled by genes which may be oligogenic or polygenic in nature. Characters, which show continuous distribution, are polygenic in nature. Most of the plant characters related to growth, yield and productivity belong to this category. The agronomic characters of medicinal plants are no exemptions. Such characters show different levels of interrelationships between them and such relationships can be identified by correlation analysis. Five morphometric characters *viz*., leaf length, leaf breadth, petiole length, leaf area and stabilized internodal length were studied for correlation analysis in this species (Table 4). All the characters except internodal length showed significant positive correlation towards each other.

Correlation of characters shows their interrelation ship. Characters with significant positive correlation usually show similar trends of variation providing an opportunity for their selection jointly. This is very much important in breeding programmes by selection since the bulk of characters to be used for selection get reduced considerably. Similar approaches have been used by earlier workers in different crops like tea (Ramasubramanian, 2005), Dahlia (Misra *et al*., 1990) and Taramira (Sodani *et al*., 1990).

Table 4. Correlation of quantitative morphological characters in the case of *Gmelina arborea*

Characters	Leaf length	Leaf breadth	Petiole length	Leaf area
Leaf length				
Leaf breadth	0.991269			
Petiole length	0.638653	0.722627		
Leaf area	0.994066	0.996567	0.692279	
Stabilized internodal length	-0.49684	-0.56639	-0.68823	-0.55554

In conclusion, among the characters studied for morphological variability, leaf area showed the maximum variability. Morphological variability of characters indicates the genotypic differences between the different accessions of the species studied. Such differences can be considered as valuable sources of gene differences that can be exploited in propagation and breeding programmes. Phytochemical analysis with the help of HPLC in the case of the above five species revealed differential levels of chemical affinities, very often associated with population distances and differences. Such variation can also be exploited both for commercial and plant breeding purposes. Biological characters, especially polygenic characters show different levels of interrelationships in any species. A preliminary attempt has been made presently to work out such interrelationships in the case of some morphological characters in this species studied by way of correlation analysis. The study of such interrelationships may help in the identification of characters that can be used as lead characters in selection programmes.

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