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***In-situ* Assessment of Diversity in *Suganda pala* (*Hemidesmus indicus* (L) R. Br.) With Special Reference to Leaf Traits**

V. Kamala¹, N. Sivaraj^{2*}, S.R. Pandravada³ and B. Sarath Babu⁴

¹⁻⁴ICAR-National Bureau of Plant Genetic Resources, Regional Station, Hyderabad, Telangana, India

ABSTRACT

Diversity in *Suganda pala* germplasm [*Hemidesmus indicus* (L) R. Br.], a common perennial herb (climber) belonging to the plant family Asclepiadaceae had been assessed *in-situ*. Ten accessions of *Suganda pala* collected from four districts (Anantapur, Chittoor, Cuddapah and Kurnool) formed the part of diversity assessment study. The germplasm accessions exhibited a good variability in morphological traits such as leaf shape, size, margin, tip, leaf lamina colour, midrib colour; stomatal frequency, leaf weight and biochemical parameters *viz.*, total chlorophyll (7.1-35.4 mg/g), chlorophyll a (11.5-36.7 mg/g), chlorophyll b(8.0-40.1 mg/g) and total carotenoids (4.8-22.8 mg/g). The leaf shape varied from elliptic-oblong, ovate to linear-lanceolate; leaf margin entire-slightly wavy; leaf tip acute-pointed; leaf midrib colour (green/pink). Leaf colour variations on dorsal and ventral sides were grouped using standard colour charts. DIVA-GIS grid map generated for various leaf traits indicated that highly diverse germplasm occurs in Chittoor district. Therapeutic classification index for *suganda pala* is highlighted.

KEYWORDS

Hemidesmus indicus, DIVA-GIS, Diversity, Conservation, *Suganda pala*



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INTRODUCTION

Hemidesmus indicus (L.) R. Br. – *Suganda pala*, is an important medicinal herb distributed throughout India from the upper Gangetic plains to central, western and southern India. Traditionally, it is used as a tonic, diuretic, blood purifier and alterative (Varaprasad *et al.*, 2006). Tribal healers use *Suganda pala* for treating rheumatism, skin diseases, venereal diseases and nephritic disorders (Vedavathy *et al.*, 1997). *Suganda pala* is reported to have the pharmacological actions such as alterative, depurative, diaphoretic, immunodepressant etc. Its action in Ayurveda includes *Kushtam*, *Amavishnashanam*, *Varnya*, *Jwaram*, *Dahaprashamana*, *Prameham*, *Pittadaham*, *inflammations*, *Raktapittaghna*, *Sugandhi*, *Doshtrayanashanam* etc. The natural population of *Hemidesmus indicus* is dwindling at an alarming rate during recent years in many parts of our country. Concerted efforts are required for the sustainable utilization, commercial exploitation and conservation of this species *in-situ*. Assessment of diversity for this economically important species would help the researchers in planning proper management strategies including crop improvement programmes and conservation initiatives. Considering its importance, the

National Bureau of Plant Genetic Resources (NBPGR) being the nodal organization in India for the collection and conservation of plant genetic resources, conducted a germplasm exploration mission in the Rayalaseema region of Andhra Pradesh for the collection of medicinal plants diversity including *Hemidesmus* germplasm. In view of the above mentioned facts, an attempt has been made to assess the existing endemic diversity in *suganda pala* germplasm accessed from Rayalaseema region of Andhra Pradesh so as to follow suitable conservation strategy and sustainable utilization of this highly valuable species.

Characteristics of the study area

The study area falls under the Rayalaseema region of Andhra Pradesh consisting of Ananthapur, Chittoor, Cuddapah and Kurnool districts. The climate is tropical in nature. Three seasons are distinguished in the study area viz., i) the hot season, ii) the rainy season and iii) the cold season. The annual average rainfall from NE monsoon is 700 to 1000mm and 300-450mm during SW monsoon. The maximum and minimum temperatures during SW monsoon range from 36°C to 40°C and 23°C to 25°C, respectively. Shallow to moderately deep red loamy soils were predominant in the surveyed pockets. Red sandy soils and



black cottons are also seen in some pockets of the study area. Some of the Eastern Ghats hill ranges located in the study area are Nallamala range (Kurnool), Yerramala range (Cuddapah), Palakonda-Seshachalam-Lankamala-Veligonda- Nagari hill ranges (Chittoor). Vegetation type varies with altitude (Scrub: 400-700m; Deciduous: 800-1200 m and Semi-evergreen: 1300 -1600 m) in the zone. The study area is inhabited by several tribal groups *viz.*, *Yanadis*, *Nakkalas*, *Irulas*, *Yerukulas*, *Chenchus*, and *Sugalis* or *Lambadas*.

MATERIALS AND METHODS

National Bureau of Plant Genetic Resources (NBPGR), Regional Station conducted germplasm surveys for the systematic collection of medicinal plants from South East coastal zone of India. A total of 10 *Hemidesmus indicus* (Indian sarasaparilla) germplasm accessions collected from Rayalaseema region of Andhra Pradesh was used for the present study. Biased sampling method was followed for *in-situ* assessment of diversity. Passport data were recorded for each *suganda pala* accession. This involved recording of passport data including geographical coordinates site description. Global Positioning System handheld receiver (GPS-Garmin 12) was recording

lat-long coordinates. To know the spatial distribution, diversity and assessment of richness DIVA-GIS version 7.5.0 (Hijmans *et al.*, 2012) was used. Grid map for *suganda pala* collection sites and richness was generated with the help of point -to -grid analysis using circular neighbourhood method. Analysis was all based on the location (latitude and longitude) and additional attributes of point data. Leaf colour grouping was done using the Royal Horticultural Society's Fifth edition colour chart. Leaf measurements were taken using digimatic calipers (Mitutoyo Corporation, Japan) and the leaf pigments such as total chlorophyll, chlorophyll 'a'; Chlorophyll 'b' and total carotenoids were estimated using standard procedures as prescribed by Sadasivam and Manickam (1996).

RESULTS AND DISCUSSION

Ten accessions of *Suganda pala* germplasm observed from the natural habitats (forest regions) of four districts (Anantapur, Chittoor, Cuddapah and Kurnool) were characterized in this study. The site of occurrence and the grid map generated for richness of *Hemidesmus indicus* using DIVA-GIS software is presented in Fig. 1. The passport information on the suganda

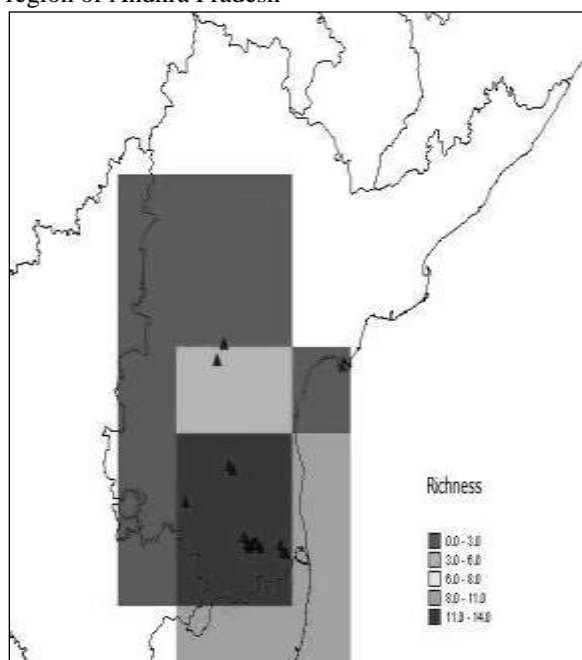


Suganda pala germplasm with geographical coordinates was provided in Table 1.

Table 1 Passport information of *Suganda pala* (*Hemidesmus indicus*) germplasm

S.No.	IC No	Village	DS Division	District	Latitude	Longitude	Altitude
1.	IC 571849	Akash Ganga	Tirupati Range	Chittoor	13.4205	79.2023	869
2.	IC 571850	Akash ganga	Tirupati Range	Chittoor	13.4205	79.2023	869
3.	IC571864	Tirumala Hills, Chaitanyapuram	Mamandur Range	Chittoor	13.4125	79.2836	640
4.	IC571870	Nacharam Cheruvu	Chamala Range	Chittoor	13.4116	79.1615	261
5.	IC571878A	Ubbalamadagu, Kambakkam Hills	Kambakkam Range	Chittoor	13.3703	79.5113	55
6.	IC571878B	Ubbalamadagu, Kambakkam Hills	Kambakkam Range	Chittoor	13.3703	79.5113	55
7.	IC 571884	Matchaikunta	Lankamalai Range	Kadapa	14.3448	79.0014	156
8.	IC 571885	Matchaikunta	Lankamalai Range	Kadapa	14.3451	79.0012	160
9.	IC571890	MPCA Kuntapalle	Kadiri	Anantapur	14.1245	78.1031	555
10.	IC571900	Atmakur	Bairlutu Range	Kurnool	15.5139	78.4416	341

Fig. 1 DIVA-GIS grid map showing collection sites and richness of *Hemidesmus indicus* in Rayalaseema region of Andhra Pradesh



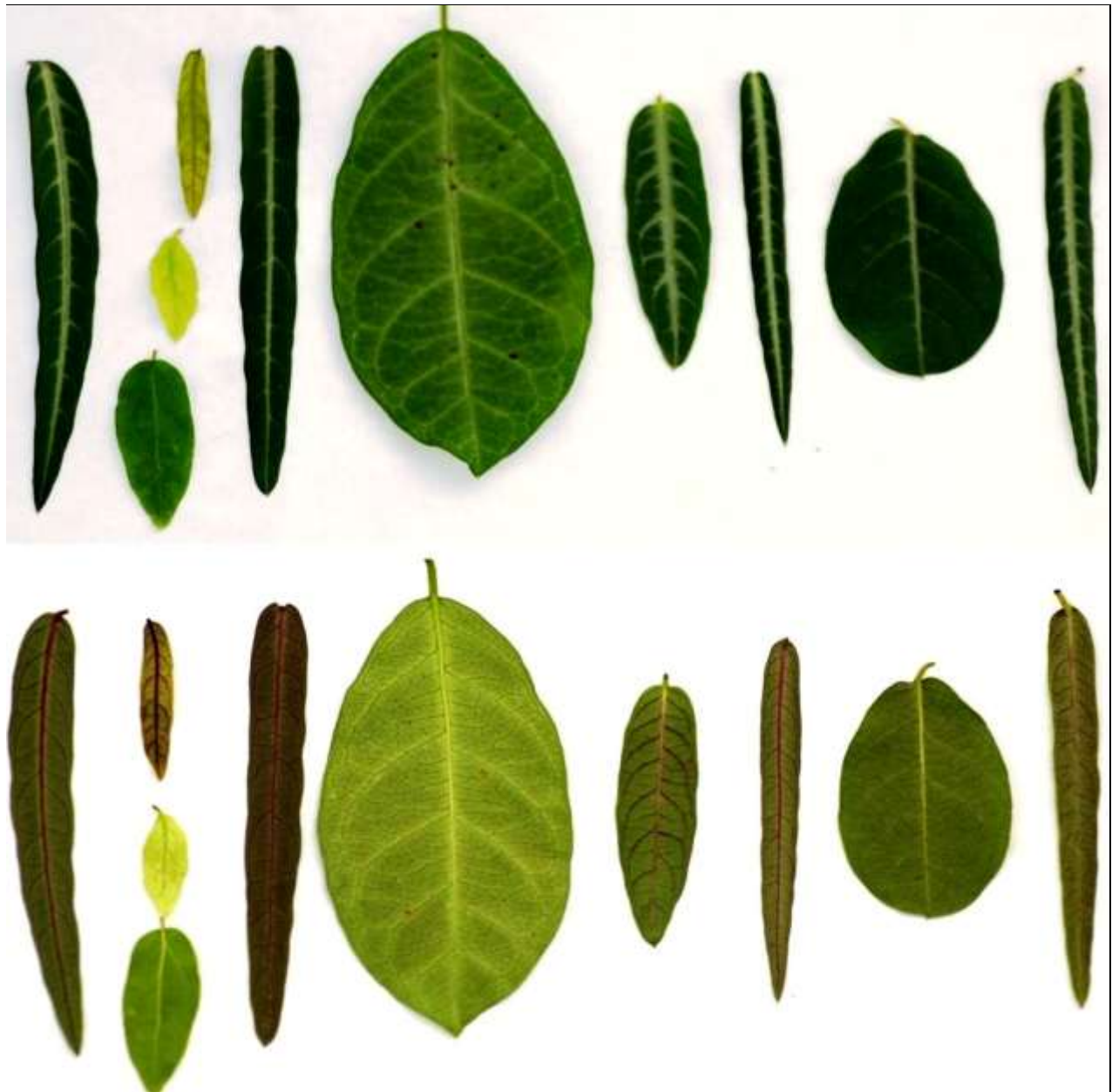
The altitudinal range for *Hemidesmus indicus* collections ranged between 55 and 869 m in the study area. All the accessions are found to be perennial prostrate or twining shrub; root-stock woody, thick, rigid, cylindrical; bark brownish corky,

marked with longitudinal furrows and transverse fissures, with aromatic smell. Stems woody, slender, thickened at the nodes. Leaves opposite, petiolate, much variable, linear to broadly lanceolate, acute or ovate, entire, smooth, shining, dark green, later variegated with white above. Flowers in racemes or cymes in opposite axils, small, green outside, purple within; corolla tubular. Fruit of two follicles, long, slender, tapering, spreading. Seeds with silvery white coma. Flowering phenology indicated that it flowers almost throughout the year. Variability in plant habit existing among the collected germplasm accessions of *Hemidesmus indicus* is depicted in Fig.2. Interestingly, leaf colour variations on dorsal and ventral sides were observed (Fig.3). The dorsal side leaf lamina colour can be grouped in to two broad groups viz., green

Fig. 2 Variability observed in the plant habit of *Suganda pala indicus* germplasm



Fig. 3. Leaf shape and colour variation in *Hemidesmus indicus* (Top row: Dorsal view; Bottom row: Ventral view)



group (137A, B; 139A, C), yellow-green group (144A, D; 147A, B) while colour on the ventral side grouped into four major groups namely, green group (136b; 139D), Yellow-green group (144A, D; 147C; 148A; 148B), greyed-green group (197A) and

purple group (77C) based on the comparative analysis with the Royal Horticultural Society's Fifth edition colour chart.

Suganda pala germplasm accessions also exhibited a good range of variability in other

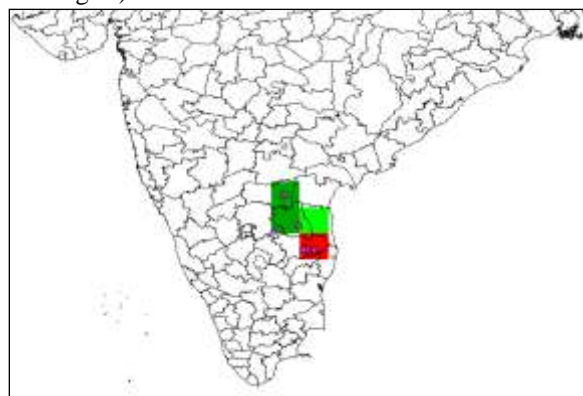


morphological traits too such as leaf shape, size, margin, tip, leaf lamina, midrib colour, stomatal frequency, leaf weight and biochemical parameters viz., total chlorophyll, chlorophyll a, chlorophyll b and total carotenoids. The leaf shape varied from elliptic-oblong, ovate to linear-lanceolate; leaf margin entire-slightly wavy; leaf tip acute-pointed; leaf midrib colour (green/pink). Leaf length ranged from 1.86 cm to 8.24 cm with a mean value of 5.99 cm while leaf width (0.43 cm-3.2 cm) and thickness (0.33-0.66 mm) possessed mean values of 1.45 cm and 0.42 mm respectively. Numbers of stomata were more on the ventral side of the leaves as compared to the dorsal side with anomocytic type of stomata. Weight of five leaves in the germplasm accessions ranged between 0.09 g to 1.62g with a mean value of 0.55 g. The total chlorophyll, chlorophyll 'a', chlorophyll 'b' ranged between 7.1 & 35.4, 11.5 & 36.7 and 8.0 & 40.1 mg/g of leaf tissue, respectively (Table 2). Total carotenoid content ranged from 4.85 mg to 22.8 mg with a mean value of 14.05mg per gram of leaf tissue in the *Suganda pala* germplasm studied.

DIVA-GIS grid map generated for the diversity analyses of leaf parameters such as leaf length, width, thickness, total

chlorophyll, total carotenoids, chlorophyll a and chlorophyll b is provided in Fig.4.

Fig. 4 Diversity analysis grid map generated for leaf traits (leaf length, width, thickness and pigments) in *Hemidesmus indicus* (high diversity region indicated as red grid)



It indicated that highly diverse *suganda pala* germplasm occur in Chittoor district of Andhra Pradesh state. Hence *in-situ* conservation sites can be ideally located in Chittoor district of Andhra Pradesh. However, three of the medicinal plants conservation areas (MPCAs) located in the study area which were established by the Andhra Pradesh State forest department possessed this important species for conservation *in-situ* (Jadhav and Reddy, 2002). GIS may be effectively used for documentation, diversity analysis, identifying gaps in collection, assessment of loss of diversity, developing new strategies for conservation, and sustainable utilization of medicinal plants and other genetic resources, particularly in the wake of recent international developments related to food,

Table 2 Variability observed in leaf traits of *Suganda pala* (*Hemidesmus indicus*)

IC No	Leaf Shape	Midrib colour	Leaf weight (g)	Leaf length (cm)	Leaf width (cm)	Thickness (mm)	Total carotenoids (mg/g)	Chl a (mg/g)	Chl b (mg/g)	Total chlorophyll (mg/g)
IC571849	Elliptic with acute tip	Green	0.33	3.50	1.56	0.33	11.86	26.53	21.26	18.81
IC 571850	Linear lanceolate with acute tip	Green	0.14	5.04	0.43	0.33	4.85	11.52	8.00	7.09
IC571864	Elliptic with pointed tip	Green	0.09	1.86	0.92	0.38	5.45	12.41	8.78	7.77
IC571870	Linear lanceolate with acute tip	D:Green; V:Purple	0.64	8.24	1.04	0.48	17.13	35.05	31.17	27.58
IC571878A	Linear lanceolate with acute tip	Green	0.53	7.20	1.12	0.46	17.23	25.31	17.74	15.71
IC571878B	Ovate with acute tip	Green	0.64	4.74	2.82	0.38	20.96	36.75	40.06	35.42
IC571884	Linear with acute tip; lamina light purple	D:Green; V:Purple	0.46	7.20	1.06	0.35	16.92	34.78	32.02	28.32
IC571885	Linear with wavy margin and acute tip	Green	0.60	7.36	1.34	0.40	11.00	35.66	38.94	34.43
IC571890	Linear with acute tip	D:Green; V:Purple	0.46	6.72	1.02	0.44	12.33	34.92	32.03	28.34
IC571900	Ovate with acuminate tip	Green	1.62	8.02	3.20	0.66	22.80	27.18	20.68	18.30

health and nutritional security. DIVA-GIS has been successfully used in identifying areas of high diversity in *Phaseolus* bean

(Jones *et al.*, 1997); wild potatoes (Hijmans *et al.*, 2001); horsegram (Sunil *et al.*,2008); *Jatropha curcas* (Sunil *et al.*,2009); linseed



(Sivaraj *et al.*, 2009); blackgram (Babu Abraham *et al.*, 2010); *Canavalia* fatty acids (Sivaraj *et al.*, 2010); medicinal plants (Varaprasad *et al.*, 2007): piper (Parthasarathy *et al.*, 2006) and agrobiodiversity (Varaprasad *et al.*, 2008). The tribal communities such as *Yanadis*, *Nakkalas*, *Irulas*, *Yerukulas*, *Chenchus*, *Sugalis* or *Lambadas* possess extensive knowledge on household remedies using *suganda pala*. Extracts and alkaloids

from the leaves of *suganda pala* have been reported to have antiasthmatic, bronchodilatory, anti-inflammatory, antiallergic, and immune suppressive properties. The alcoholic extract and total alkaloids of *suganda pala* leaves have shown an antispasmodic effect in isolated tissues. Therapeutic classification index as sourced from published literature is presented in Table 3.

Table 3 Therapeutic classification index for *Suganda pala* (*Hemidesmus indicus*)

Therapeutic System	Treatment
Central nervous system	Its alterative and pacificator nature extends to the mind, hence its use in disturbed, angry or irritated emotions aggravating the equilibrium of the mind.
Respiratory system	It is given in expectorant cough and dyspnea
Digestive system	Useful herb for stimulating the appetite aggravating any acidity. It is a benefit to sluggish digestion. Used in inflammation of the mucus membranes throughout the body. Also used in diarrhea.
Reproductive system	Traditional use for maintaining pregnancy and preventing habitual abortions. Used to increase the quantity and quality of breast milk. Also may be of benefit for menorrhagia Classified as a sperm increasing herb, it is of value in fertility problems, low libido. Its saponin content is considered to have a steroidal effect that enhances the production of testosterone
Skin	Clear heat and inflammation from the skin- used in eczema, erysipelas, psoriasis, urticaria from heat. It 'cleans' the blood, stops itching and reduces supperation. The root powder is used to treat STDs that are damp and hot. Used as an external paste or in a cream it can benefit red, hot, oozing inflammatory skin problems. It is a specific for acne
Genito- urinary system	Urinary infections with dark red, cloudy, painful urination; cystitis, urethritis, kidney infections, prostatitis
Tribal health care	<ul style="list-style-type: none"> • Fissures in the feet: Roots of <i>Suganda pala</i> and <i>Rubia cordifolia</i> (1:1) powdered and mixed in gingelly oil and boiled. Honey bee wax is added as base and applied to fissures (Vedavathy <i>et al.</i>, 1997) • Tooth ache: Roots of <i>suganda pala</i>+<i>Cassia auriculata</i>+leaves of <i>Plumbago zeylanica</i> +whole plant of <i>Adiantum caudatum</i> are burnt and the ash is applied to carious teeth (Vedavathy <i>et al.</i>, 1997) • Tonic: Root decoction with milk and sugar given to children to cure chronic cough and diarrhoea. (Vedavathy <i>et al.</i>, 1997)

(Source: <http://www.la-medica.com>: Vedavathy *et al.*, 1997)

It is also used to make a beverage which is promoted by local self-help groups in the

study area. The syrup made with an infusion of roots is called as *Nannari Sherbet* and is



served at small petty shops in South India. Several reports indicated the presence of various phytochemicals in *Hemidesmus indicus*. Coumarins, triterpenoid saponins, essential oil, starch, tannic acid, triterpenoid saponins are present. Leaves contain 2.5% tannins and new coumarino-lignoid-hemidesminine (Leucoderma lignoids), hemidesmin I and hemidesmin II, six pentacyclic triterpenes including two oleanenes, and three ursenes. A stearopten smilasperic acid is also obtained by distillation with water. The roots of *suganda pala* contain hexatriacontane, lupeol, its octacosanoate, α -amyirin, β -amyirin, its acetate and sitosterol (Chatterjee and Bhattacharya, 1955). The stem contains calogenin acetylcalogenin-3- β -D-digitoxopyrannosyl-0- β -D-digitoxopyransyl-0- β -D-digitoxopyranoside. It also afforded 3-keto-lup-12-en-21 28-olide along with lupanone, lupeol-3- β -acetate, hexadecanoic acid, 4-methoxy-3-methoxy benzal aldehyde and 3-methoxy-4-methoxybenzaldehydglycosides-indicine and hemidine. Subramanian and Nair (1968) reported the presence of flavonoid glycosides viz., hyperoside, isoquercitin and rutin in the flowers while hyperoside and rutin only in the leaves. It is anticipated that

a vast scope exists for studying the various phytochemicals in the collected germplasm. We believe that the results of the study would be useful for planning effective genetic resources management strategies for *Suganda pala*, a medicinally valuable, economically important life supporting species, and its sustainable utilization in the Eastern Ghats region.

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