Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 01, pp.25009-25013, January, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

FLORAL AND FRUIT VARIATIONS AMONG *GARCINIA IMBERTI,* AN ENDANGERED ENDEMIC TREE SPECIES OF SOUTHERN WESTERN GHATS

***Anto, M., Prajith, T. M., Jothish, P. S. and Anilkumar, C.**

Seed Bank, Conservation Biology Division, Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Pacha – Palode, Thiruvananthapuram, Kerala - 695 562

ARTICLE INFO

Article History:
Received 22nd October, 2015
Received in revised form
10th November, 2015
Accepted 15th December, 2015
Published online 31st January, 2016

Key words:

Garcinia imberti, Floral and fruit variation, Southern Western Ghats.

ABSTRACT

Garcinia imberti Bourd. is an endangered endemic niche specific dioecious species of southern Western Ghats. The field studies conducted from three populations *viz.* Chemunji, Bonacaud and Ponmudi revealed pioneer observation of individual accessions which differs in floral colour as well as number of seeds per fruit at different sites. The present study may suggest cues on the ecological scope of variations among some accessions with respect to enhanced chance of pollination, fruit set and subsequent seed dispersal ensure species survivorship.

Citation: **Anto, M., Prajith, T. M., Jothish, P. S. and Anilkumar, C. 2016.** "Floral and fruit variations among *Garcinia imberti,* an endangered endemic tree species of southern western Ghats", *International Journal of Current Research,* 8, (01), 25009-25013.

INTRODUCTION

Garcinia imberti Bourd. was originally described by Bourdillon from Tirunelveli hills (Bourdillon,1899). Almost after a century, this species was relocated by Mohanan *et al.* (1997) from Travancore area of southern Western Ghats. Saradamma *et al.* (1994) reported that tribals of the area use the exudates from the stem bark of *G. imberti* as an antiseptic for wounds. IUCN (2015) enlisted this endemic species as endangered which is vulnerable to environmental and demographic stochastic events which may lead to its extinction. In this background, present study aims to describe the features of variant accessions among populations of *G. imberti* for strengthening species conservancy based on the knowledge on existing range of ecological adaptivity.

MATERIALS AND METHODS

The study was carried out during the three consecutive flowering seasons (2013 - 2015) of the *Garcinia imberti* natural populations at the Agasthyamala Bio reserve of southern Western Ghats, which comprises Chemunji (1012-1186m), Bonacaud (943m) and Ponmudi (1003m) areas. Accessions with floral variations were marked as (Fl) while that of 3 - 4 seeded fruits as (Fr). Fruits were categorized in to four types based on number of seeds possess such as SSF (Single seeded fruit), DSF (Double seeded fruit), TSF (Triple seeded fruit) and TRSF (Tetra seeded fruit). Floral (Fl) as well as fruit (Fr) morphological features of variant accessions were comparatively studied with control species. Phenological event related to flowering and fruiting period were recorded during the three consecutive years. Floral measurements were carried out with the aid of a vernier scale and by a simple microscope. Photographs of the representative structures were taken using a Canon EOS 7D camera. Altogether 9 floral characters were studied (Table 1) such as flower length, flower width, sepal colour sepal length, sepal width, petal colour, petal length, petal width and pistil length were measured as per methods of Joseph and Murthy (2015) in both control and variant female (Fl) accession at Ponmudi. The fruit characters were also measured in both control and variant female (Fr) accession at Bonacaud. The shapes of fruits were studied according to the method proposed by Hickey (1973). The colour of flowers and fruits were examined visually and compared with the color identification chart of Royal Botanic Garden, Edinburg. The data were subjected to analysis of variance (ANOVA) using

**Corresponding author: Anto, M.*
Seed Bank, Conservation Biology Division, Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Pacha – Palode, Thiruvananthapuram, Kerala - 695 562

the statistical package of Social Sciences version 12.0 (Windows. SPSS Inc.).

RESULTS AND DISCUSSION

Garcinia imberti usually attains height of 10 - 23 metre (m) tree species, endemic to the Agasthyamala Bio reserve of the southern Western Ghats but at higher altitudes of above 1250 m exhibit stunted growth. Flowers are unisexual and male flowers borne on terminal fascicles. Female flowers are also terminal but solitary. The flowering period spreads from January to May within which male flowers start to initiate two to three weeks before the induction of female flowers as reported in other dioecious species (Lioyd and Webb, 1977; Wilson, 1979; Beach, 1981) (Table.1). In *G. imberti*, male plants bear more flowers than female plants as similar with other dioecious species (kay *et al*., 1984; Armstrong and Irine, 1989; Muenchow and delesalle, 1994; Vaughton and Ramsey, 1998). Floral variant accession (Fl) occurring at Ponmudi area show phenotypically distinct female floral structure. On contrary to the control, the light greenish yellow colored petals of Fl accessions possess visibly contrasting deep yellowish pink patches which shows larger and thicker (Fig.1).

Colouration gives an idea about the study of evolutionary processes within species (Rausher, 2008). Dimensions of both petals and sepals of Fl accession show significant variations from the control (Table 1). Flower colour is one of the best studied floral traits which relate the genetic and ecological diversity (Smith and Goldberg, 2015) and it is thought to play an important role in attracting pollinators to patches and may mediate competition or facilitation for pollinators within patches (Levin and Anderson 1970; Ghazoul ,2006). Widely opened petals with unique colour patches and significant pistil length of F accession may contribute pollination events are so effective, which was clearly evidenced from high rate of fruit set as 40 % against 25 % of control species. Indeed, colour is among the most recognizable signals in the identification of 'pollination syndromes' relating to the perception and preference of pollinators (Faegri and van der Pijl 1979; Gumbert *et al*., 1999; Fenster *et al*., 2004; Lazaro *et al*., 2008). Brilliant yellowish green colored fruits of F accession possess distinct vivid yellowish pink patches over fruit surface after maturation and the plane of seed which attached with the axis also have same pattern of coloration (Fig.1). Floral pigmentation are influencive in many physiological responses such as UV, stress and also fruit coloration (Chalker-Scott, 1999; Winkel-Shirley, 2001).

Table 1. Comparison of floral traits (Mean ± SE, n= 15) between Control (C) and variant accession (Fl) of *G. imberti.*

Characters	Control accession (C)	Variant accession (Fl)
Sex	Female	Female
Flowering period	February to May	March to May
Flower length (mm)	6.2 ± 0.01	7.9 ± 0.01**
Flower width (mm)	4.8 ± 0.02	5.3 ± 0.01**
Sepal colour	Light greenish yellow	Light greenish yellow
Sepal length (mm)	2.6 ± 0.01	2.9 ± 0.03**
Sepal width (mm)	2.4 ± 0.01	2.6 ± 0.02**
Petal colour	Light greenish yellow	Light greenish yellow with deep yellowish pink patches
Petal length (mm)	2.5 ± 0.02	2.7 ± 0.04**
Petal width (mm	2.7 ± 0.05	3.3 ± 0.03**
Pistil length (mm)	2.3 ± 0.02	3.4 ± 0.03**

Results are represented as means (±SE) in the column with (**) (*) (ns-not significant) according to LSD at the 5 % and 1 % levels (P < 0.0 5& 0.01; n = 15).

Table 2. Comparison of fruit variation (Mean ± SE, n=15) between Control (C) and variant accession (Fr) of *G. imberti*

Characters		Control accession (C)		Variant accession (Fr)			
Sex		Female		Female			
Fruit colour		Brilliant yellowish green		Brilliant yellowish green with vivid yellowish pink patches			
Rind surface		Smooth		Thin, smooth			
Fruit shape	SSF	Narrow elliptic		Narrow elliptic			
	DSF	Elliptic		Elliptic			
	TSF	-		Narrow obovate			
	TESF	-		Wide elliptic			
No. of seeds/ fruit		1 - 2		1 - 4			
		SSF	DSF	SSF	DSF	TSF	TESF
Type of fruit (%)		57.89±1.68	42.11±1.68	63.57±5.90	32.03±5.98	3.34±0.38	1.05±0.19
Length of fruit (mm)		29.29 ± 0.70	32.20 ±2.35	37.90±0.37	42.28±0.48	37.59 ± 0.68	53.02 ± 0.34
Breadth of fruit (mm)		14.05 ± 0.22	18.75 ±0.29	20.49±0.39	28.55±0.37	20.00 ± 0.50	28.86 ± 0.23
Width of fruit (mm)		13.57 ±0.22	13.07 ±0.17	19.04±0.42	19.06±0.42	19.18 ± 0.45	30.52 ± 0.20
Fresh weight of fruit (g)		2.63 ± 0.10	3.41 ± 0.13	3.11±0.13	4.16±0.21	5.52 ± 0.29	11.83 ± 0.37

SSF: single seeded fruit, DSF: double seeded fruit, TSF: triple seeded fruit, TESF: tetra seeded fruit.

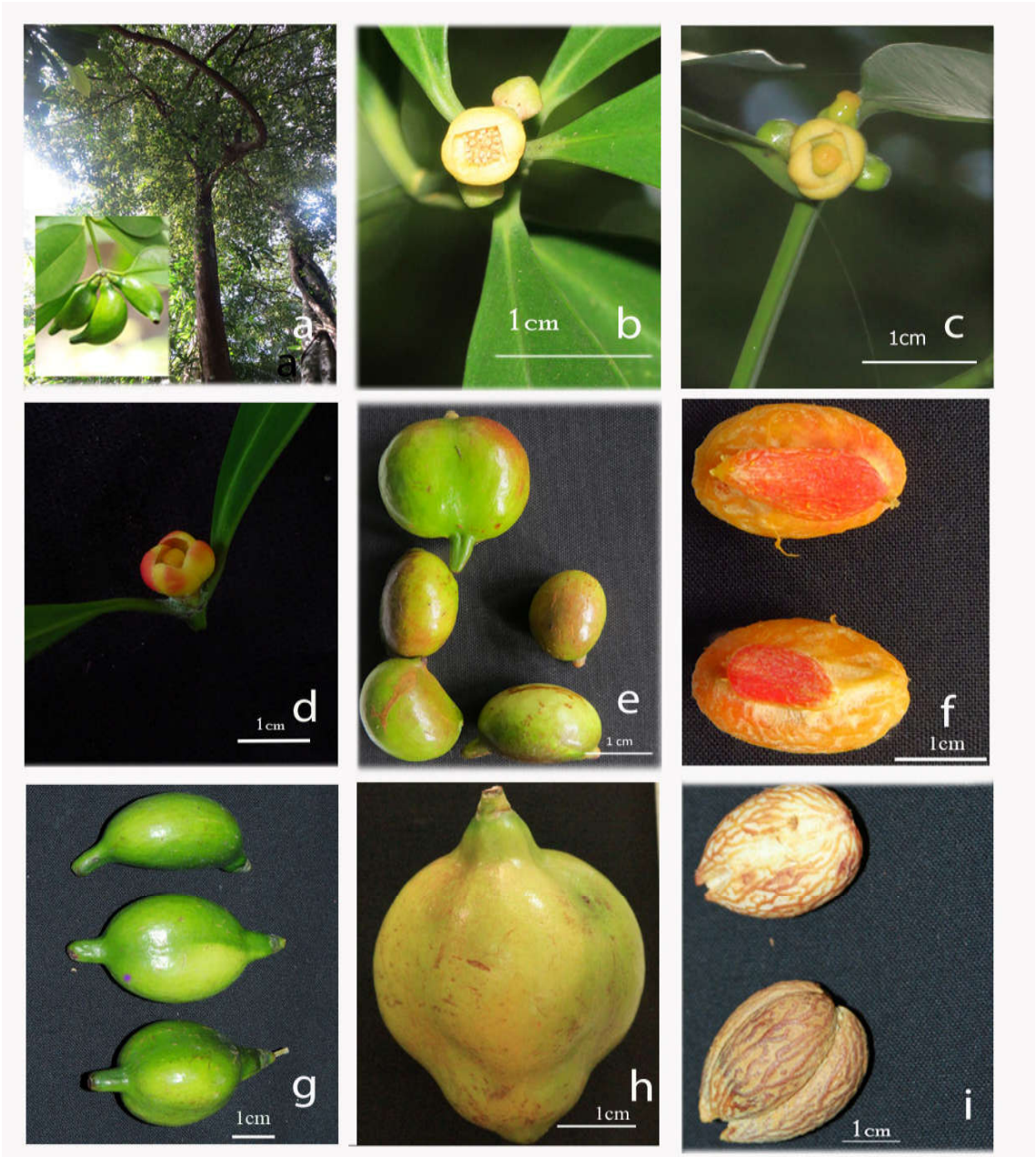

Fig. 1., a. Habit., b. Male flower., c. Female flower., d. Coloured female flower., e. Coloured fruits., f. Coloured seeds., g. Single, double and triple seeded fruit., h. Tetra seeded fruit., i. Double and triple seeds

The fruiting period was distributed between last week of April to November in both control and Fr accession. In normal condition, fruits of *G. imberti* bears one or two seeds with occurrence of 57.9 and 42.1 % respectively while Fr accessions carry additional 3 or 4 seeded fruits. The percentage of four seeded fruits (TESF) ranges 1.05 % and 3.34 % for three seeded fruits (TSF). Each category of fruits have distinct shapes which ranges from narrow elliptic (SSF), elliptic (DSF), narrow obovate (TSF) and wide elliptic (TESF) (Table 2). The Fr accession of *G. imberti* was located at an isolated point, thus the increased number of seeds per fruit with small size may be an adaptation for higher dispersal capacity (Dirzo and Dominguez, 1986). Under competitive conditions, large seed size has been found to confer an advantage of higher seedling survival and growth (Westoby *et al*., 1996) but dispersal capacity was minimum (Werner and Platt, 1976). Seed mass variation among populations or between fruits within plants may also result from variation in pollination intensity, which have an important effect on seed number (Piper *et al*., 1986; Wolf *et al*., 1986; Lee, 1988). On contrary with control, the Fr accession possesses distinct fruit pulp after maturation over seed coat with pleasant fragrance which may influence the attraction of predators at certain level as a dispersal strategy. Small, fragmented and isolated populations always tend to

contribute low fruit and seed production due to the decrease in pollen quantity and reduced pollination intensity (Jennersten, 1988 Agren, 1996; Kwak *et al*., 1998) while on contrary, the Fr accession in the small population of *G. imberti* at Bonacaud region produced high rate of fruits with increased seed number which may unwraps the possibility of apomixes in addition with high pollination intensity for maintaining population size (Kwak *et al*., 1998). The rich available status of resources (Mazer, 1987; Winn and Werner, 1987) also point out a reason for high fruit production in the variant accession (Fr) of *G. imberti*. Present study suggested that the unique morphological and physiological features of variant *G. imberti* accessions (Fl and Fr) gives status of distinct lineage, which may can lead as a hint against ecological adaptation of species with further conformation at genetic and molecular level.

Acknowledgement

The authors greatly acknowledge the Director, JNTBGRI for facilities provided and Department of Science and Technology (DST) for financial support.

REFERENCES

Agren, J. 1996. Population size, pollinator limitation, and seed set in the self- incompatible herb *Lythrum salicaria*. *Ecology,* 77:1779 - 1790.

Anonymous, 1969. Colour identification chart. *Flora of British fungi*, Her Majesty's stationary office, Royal Botanic Garden, Edinburgh, London.

Armstrong, J. E. 1997. Pollination by deceit in nutmeg (*Myristica insipida*, Myristicaceae): floral displays and beetle activity at male and female trees. *Am. J. Bot.,* 84:1266 - 1274.

Armstrong, J. E. and Irvine A. K. 1989. Flowering, sex ratios, pollen-ovule ratios, fruit set and reproductive effort of a dioecious tree, *Myrstica insipida* (Myristicaceae), in two different rain forest communities. *Am. J. Bot.,* 76: 74 - 85.

Bourdillon, T. F. 1899. Descriptions of some new or rare trees from Travancore. *Journal of Bombay Natural History Soceity,* 12: 349 - 351.

Chalker-Scott, L. 1999. Environmental significance of anthocyanins in plant stress responses. *Phytochemistry and Photobiology,* 70: 1 - 9.

Cooley, A. M., Modliszewski, J. L., Rommel, M. L., and Willis, J. H. 2011. Gene duplication in Mimulus underlies parallel floral evolution via independent trans-regulatory changes. *Current Biology*, 21: 700 - 704.

Dirzo, R. and Dominguez, C. A. 1986. Seed shadows, seed predation and the advantages of dispersal. *In* Frugivores and seed dispersal (Estrada, A. and Fleming, T., eds.), Dordrecht: Junk, 237 - 250.

Faegri, K. and van der Pijl, L. 1979. The principles of pollination ecology. Oxford, UK: Pergamon Press.

Fenster, C. B., Armbruster, W. S., Wilson, P., Thomson, J. D. and Dudash, M. R. 2004. Pollination syndromes and floral specialization. *Ann. Rev. Ecol. Evol. Syst*., 35: 375 - 403.

Ghazoul, J. 2006. Floral diversity and the facilitation of pollination. *Journal of Ecology*, 94: 295 - 304.

Gumbert, A., Kunze, J. and Chittkar, L. 1999. Floral colour diversity in plant communities, bee colour space and a null model. *Proc. R. Sco. Lond*. B., 266:1711 - 1716.

Hickey, L. J. 1973. Classification of the architecture of dicotyledonous leaves. Division of Paleobotany, Smithsonian Institution, Washington, D.C. *Am. J. Bot*., 60 (1): 17 - 33.

Jennersten, O. 1988. Pollination in Dianthus deltoides (Caryophyllaceae): effects of habitat fragmentation on visitation and seed set. *Conservation Biology,* 2: 35 - 366.

Joseph, K. S. and Murthy, H. N. 2015. Sexual system of *Garcinia indica* Choisyy: geographic variation in trioecy and sexual dimorphism in floral traits. *Plant. Syst. Evol.,* 301: 1065 - 1071.

Kay, Q. O. N., Lack, A., Bamber, F. C., Davies, C. R. 1984. Differences between sexes in floral morphology, nectar production and insect visit in a dioecious species, *silena dioica*. *New Phytol,* 98: 515 - 529.

Kwak, M. M., Velterop, O., and van Andel, J. 1998. Pollen and gene flow in fragmented habitats. *Applied Vegetation Science,* 1: 37 - 54.

Lazaro, A., Hegland, S. J. and Totland, O. 2008. The relationship between floral traits and specificity of pollination systems in three Scandinavian communities. *Am. Nat*., 170: 271 - 283.

Lee, T. D. 1988. Patterns of fruit and seed production. In Plant reproductive ecology: patterns and strategies (Lovett Doust, D. and Lovett Doust, L., eds.), New York: Oxford University Press, 60 - 79.

Levin, D. A. and Anderson, W. W. 1970. Competition for pollinators between simultaneously flowering species. *Am. Nat*., 104: 455 - 467.

Lloyd, D. G. and Webb, C. J. 1977. Secondary sex characters in plants. *Bot. Rev.* (Lancaster), 43: 177 - 216.

Mazer, S. J. 1987. The quantitative genetics of life history and fitness components in *Rahpanus raphanistrum* L. (Brassicaceae): ecological and evolutionary consequences of seed-weight variation. *Am. Nat*., 130: 891 - 914.

Mohanan, N., Shaju, T., Rajkumar, G. and Pandurangan, A. G. 1997. Rediscovery of *Garcinia imberti* Bourd. (Clusiaceae), A little known endemic species of Western Ghats. *Indian Journal of Forestry*, 20 (4): 383 - 385.

Muenchow, G., Delesalle, V. 1994. Pollinator response to male floral display size in two *sagittaria* (Alismataceae) species. *Am. J. Bot.,* 81: 568 - 573

Piper, J., Charlesworth, B., and Charlesworth, D. 1986. Breeding system evolution in *Primula vulgaris* and the role of reproductive assurance. *Heredity,* 56: 201 - 217.

Rausher, M. D. 2008.Evolutionary transitions in floral color. *International Journal of Plant Sciences*, 169: 7 - 21.

Saradamma, L., Nair, R. C. P., Bhat, A.V. and Rajashekaran, S. 1994. All India Coordinated research Project on Ethnobiology; Final Technical Report, Phase II. Regional Research Institute (Drug Research) CCRAs, Govt. of India, Thiruvananthapuram. p. 108.

Smith, S. D. and Goldberg, E. E. 2015. Tempo and mode of flower color evolution. *Am J Bot.,*102(7): 1014 - 1025.

The IUCN Red List of Threatened Species. Version 2015.1. <www.iucnredlist.org>. Downloaded on 09 June 2015.

Vaughton, G. and Ramsey, M. 1998. Floral display, pollinator visitation and reproductive success in the dioecious

perennial herb *Wurmbea dioica* (Liliaceae). Oecologia, 115: 93-101.

Werner, P. A. and Platt, W. J. 1976. Ecological relationship of co-occurring goldenrods (Solidago: Compositae). *Am. Nat*., 140: 287 - 304.

Westoby, M., Leishman, M., and Lord, J. 1996. Comparative ecology of seed size. Phil. Trans. R. Soc. London B, 351: 1309 - 1318.

Whittal, J. B., Voelckel, C., Kliebenstein, D. J. and Hodges, S. A. 2006. Convergence, constraint and the role of gene expression during adaptive radiation: floral anthocyanins in Aquilegia. *Mol. Ecol*., 15: 4645 - 4657.

Willson, M. F. 1979. Sexual selection in plants. *Am. Nat*., 113: 777 - 790.

Winkel-Shirley, B. 2001. Flavonoid biosynthesis: A colorful model foe genetics, biochemistry, cell biology and biotechnology. *Plant Physiology,* 126: 485 - 492.

Winn, A. A. and Werner, P. A. 1987. Regulation in seed yield within and among populations of *Prunella vulgaris*. *Ecology,* 68: 1224 - 1233.

Wolf, L. L., Hainsworth, F. R., Mercier, T., and Benjamin, R. 1986. Seed size variation and pollination uncertainty in *Ipomopsis aggregata* (Polemoniaceae). *Journal of Ecology,* 74: 99 - 111.

****