



## Guava Breeding: A Timeline for Major Developments in the World

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### Abstract

Although guava plants were domesticated over 2000 years ago, their commercial cultivation was not reported until 1526. Since then, significant achievements have been made in the breeding of guava, and in India, work on guava improvement began for the first time in 1907. Achievements in guava breeding have significantly helped to increase the profitability of guava cultivation and have been a subject of research for several decades. Breeding programs have been successful worldwide to develop guava cultivars with improved yield and enhanced disease resistance and fruit quality. In the future, the development of genetic linkage maps, tools like marker-assisted selection (MAS), clonal fingerprinting, genome sequencing, transcriptomics, genome-wide association studies, genetic diversity analysis, etc. will facilitate crop improvement approaches in the guava.

**Keywords:** Guava breeding, Molecular markers, Pigments, *Psidium guajava* L.

### Introduction

Guava (*Psidium guajava* L.), also known as “Apple of the Tropics”, is a member of the Myrtaceae family which includes four genera (*viz.*, *Psidium*, *Feijoa*, *Syzygium*, and *Eugenia*) that produce edible fruits. It is indigenous to Tropical America (Mexico to Peru), but it has also successfully adapted to Indian conditions. It is a cross-pollinated fruit crop; all cultivated varieties are either diploids or triploids. The domestication of guava plants dates back more than 2000 years, but it wasn't until 1526 that their commercial cultivation was first reported in the Caribbean Islands. Because of its ability to survive harsh conditions, ease of culture, prolific bearing, and high remuneration and nutritional values, has resulted in widespread cultivation across tropical and subtropical regions globally. Spanish chronicler Gonzalo Fernandez de Oviedo Valdez during his visit to Haiti (Yucatan expedition), wrote the first description of the vegetative characteristics of guava plants found in the West Indies as early as 1526 and referred to it as “Guayabao”; renamed *Psidium guajava* by Linnaeus in 1753.

By the early seventeenth century, Spaniards introduced it to the Philippines, and Portuguese to India, from where it spread to Hawaii and South America. Over the decades,

guava becomes an important perennial fruit crop, whose distribution is extended from Mexico to Uruguay and Argentina. The genetic improvement of guava has been hindered by the absence of molecular approaches. Unfavorable policies have also contributed to these challenges and limit the widespread adoption of guava as a commercial fruit crop.

### Improvement Work in India

In 1907, the Ganeshkhind Fruit Experimental Station in Pune initiated the process of guava improvement through selection in India (Figure 1). Approximately 600 seedlings were raised and evaluated for various fruit and yield characteristics. Lucknow-49 guava variety, renamed “Sardar”, was released in 1927 and is a selection from Allahabad Safeda. It became very popular among farmers over time because of large, globose-shaped fruits having high TSS (12%) and sugar: acid ratio along with its spreading growth habit. Improvement *via* selection can be an effective method in guava because of the large variability present in the seedling populations owing to cross-pollination and a high level of heterozygosity in the crop, ranging from 25.7 to 41.3%.

Major breeding objectives of guava include:

- Higher productivity.

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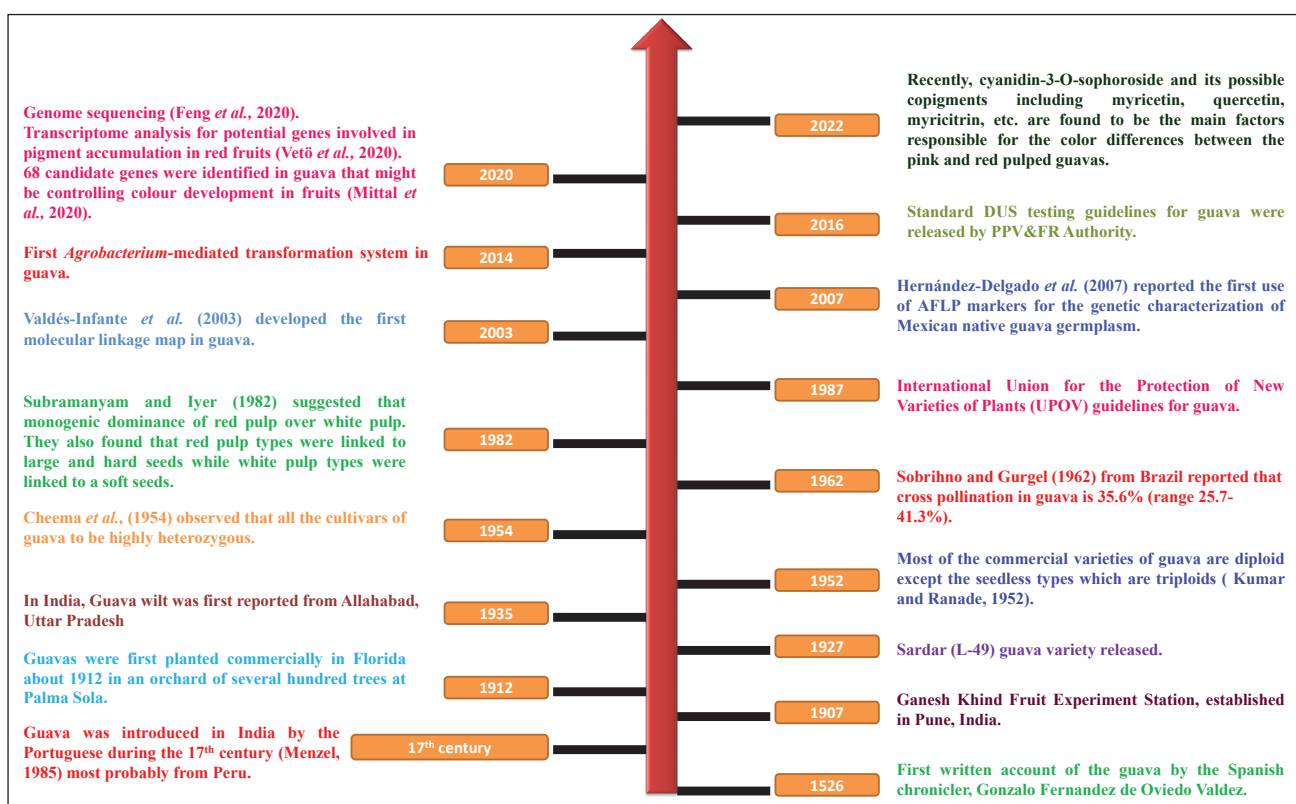


Figure 1: Timeline for major developments in guava breeding

- Resistance to *Fusarium* wilt and fruit fly.
- Colored flesh with soft-seeded fruits.
- Smooth and round-shaped fruits.
- Standardization of pruning techniques.

Major problems the guava industry faces include high seed content, misshaped fruits of triploid varieties, wilt disease, and the menace of the fruit fly. Guava wilts were first reported in India in 1935 from Allahabad, Uttar Pradesh.

#### Studies on Pulp Colour

In 1962, Sobrihno and Gurgel conducted initial research on guava pulp color inheritance in Brazil and concluded that red pulp color is dominant to white. Subramanyam and Iyer in 1982 carried out systematic studies on pulp color in guava and suggested that red-pulped genotypes were linked to large and bold seeds whereas white-pulped ones were soft-seeded. UPOV (Union for the Protection of New Varieties of Plants) published guidelines in 1987 outlining procedures for conducting tests to evaluate distinctiveness, uniformity, and stability in guava, which are crucial for identifying guava germplasm worldwide. Additionally, the task force formed by the PPV&FR authority in 2016 also suggested the standard DUS testing guidelines for guava. Most of the *Psidium* fruits are sweet-scented fleshy berries with yellow or green skin color, but have large variations with respect to the flesh color, ranging from white to purplish. Mittal *et al.* (2020) discovered 68 potential genes responsible for regulating color development in guava fruits through differential expression analysis of various colored tissues. It has been discovered that cyanidin-3-O-sophoroside,

along with copigments such as myricetin, quercetin, and myricitrin, are primarily responsible for the variation in color between the pink and red-pulped guavas. Similarly, the color of yellow-pulped guavas is mainly attributed to  $\beta$ -cryptoxanthin palmitate,  $\beta$ -cryptoxanthin myristate, and rubixanthin palmitate as the primary carotenoids.

#### Molecular Studies

Molecular markers can be effectively utilized for the differentiation of germplasm and diversity studies at the species or cultivar level in guava. Microsatellite markers have been used to characterize guava germplasm and assess its genetic diversity. Valdés-Infante *et al.* (2003) developed the first molecular linkage map in guava. Feng *et al.* (2021) carried out a comparative genome analysis in guava. The study unveiled that the genome assembly size was 443.8 Mb with 193.2 Mb consisting of repetitive sequences. Transcriptomics analysis of *Psidium cattleyanum* unveiled that anthocyanidin synthase and UDP-glucose: flavonoid-o-glucosyl-transferase are the potential genes involved in pigment accumulation in red guava fruits (Vetö *et al.*, 2020). The application of genome-wide SNPs by Díaz-García and Padilla-Ramírez (2023) marked the initial diversity studies conducted in guava.

#### Conclusion

Guava is an essential fruit crop having high nutritional qualities, but has very narrow genetic diversity. Improvement *via* selection can be an effective method because of the large variability present in the guava seedlings. The absence of molecular techniques is hindering genetic enhancement and the widespread acceptance of guava as a commercial

fruit crop worldwide. The recent availability of the reference guava genome and transcriptomic analysis is expected to expedite the study of various molecular mechanisms underlying guava, especially for the breeding of pulp color. Exploring advanced molecular tools such as genome editing, base editing, and genomic selection will further enhance research in this direction.

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