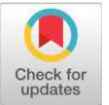


Review Article

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Lesser-known and under-utilized ornamentals for commercial cultivation

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ABSTRACT

Floriculture is a dynamic industry. What sets it apart from other agricultural sectors is the emphasis placed on novelty as a significant characteristic which can be achieved by introducing new flower crops that are lesser known to mankind. Some of these new-generation crops are proteas, gingers, curcumas, kangaroo paws, guzmanias, wax flowers etc. The Proteaceae of Southern Africa are intriguing flowers that pose an interesting example of using an undomesticated plant to an economically viable, cultivated fresh-cut flower. Among the tropical floriculture products, ornamental ginger and curcuma species have considerable potential for ornamental use, in landscaping, as cut, potted flowers and foliage with a potential for a wide range of expansion in markets. A wide range of availability of colors in anigozanthos has increased the popularity of the genus in the international flower market. Apart from the crops which can be used as cut flowers, there are some crops like bat lilies and guzmanias which have the potential to be used as ornamental pot plants. Some of the crops, like wax flowers, have a great deal of promise for use as fillers in floral arrangements. In spite of having wide-varietal wealth in terms of unique-form, vibrant-colours and long shelf-life, these plants have yet not been popularized out of their indigenous niche areas. The diverse agro-climatic conditions of the Indian sub-continent offer tremendous scope for diversification of novel, lesser-known ornamental crops. However, there is still scope for further research and improvement for various characteristics of the new crops.

Keywords: Floriculture, cut flower, fillers, pot plants, inflorescence, novel flower crops, post-harvest

1. INTRODUCTION

Ornamental plants are those that are cultivated or maintained primarily for their visual or aesthetic highlights, such as their attractive color, pleasant fragrance, or pleasing patterns and designs. These plants can add charm to the indoors and outdoors. Modern man depends mainly on high-yielding cultivated and hybrid flowers, often exotic ones, for aesthetic and recreational purposes. Novel ornamental plants are essential for maintaining and increasing market dominance in the competitive export market of potted plants and cut flowers¹. Despite the current wide assortment of ornamental plants available, there is still room for the introduction of new varieties, as there is a constant demand in the market for novelty².

The Indian floriculture industry is valued at INR 231.7 billion. With a whopping production of 3194 thousand tonnes of flowers from an area of 285 thousand hectares in 2023-24, India has paved its way into the international flower market³. The significant rise in production was made achievable thanks to the advancement of improved plant varieties and hybrids, along with the implementation of effective production and protection techniques. These developments were the result of thorough research efforts and widespread adoption by farmers. Nonetheless, this impressive increase in production primarily stemmed from a limited number of major flower crops,

including rose, tuberose, gladiolus, anthurium, carnations, marigold, etc. Given the fast-paced competition in the global market, it is crucial to engage in diversification by exploring lesser-known, under-utilized ornamental plants with promising potential that can command higher prices in the market. Most of these under-utilized ornamental plants have been introduced from Australia, South Africa, Israel, New Zealand and the Eastern USA. In fact, over 60 types of such new ornamental plants have been identified as having significant commercial value under Indian conditions. So, in view of shifting market trends it is crucial for the farmers of the Indian sub-continent that they take up the cultivation of these under-utilized but economically important ornamental crops. Moreover, the cultivation of these flower crops has the potential to serve as an additional income source for rural communities while also aiding in the preservation of genetic resources associated with lesser-known plant species.

2. NEW GENERATION/LESSER-KNOWN ORNAMENTALS

Today, floriculture has transformed into a viable agri-business. The ornamental industry distinguishes itself from other agricultural industries by placing significant value on the attribute of novelty. Consumers always seek 'something new'. Novelty crops are important in the commercial floriculture market as they help to maintain and expand the market share. These crops distinguish themselves from the regular carnations, chrysanthemums and roses. The introduction of new flower species is an important task as it meets the demand of consumers for cut flowers with unique and impressive features, and also fulfills their desire for a wide selection of flowers. This emphasizes the need for breeders to continuously develop new species with different and appealing qualities to satisfy the preferences of consumers⁴.

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The diverse agro-climatic conditions of the Indian sub-continent provide a great opportunity for the cultivation of new and unique ornamental crops that can bring in higher profits and hold enormous potential for the global floriculture industry in the future. The definitions of novel crops are:

A genus or species that has recently been discovered

OR

Reintroduced plant cultivars that were previously grown but have since been forgotten or lack complete cultural information

OR

The crops can be cultivated using novel production technologies to improve crop quality and reduce the overall production time.

The objectives for classifying an under-utilized plant species as novel ornamental crops are:

- Overall attractiveness as a cut flower
- Flower color and its range
- The potential for use (centerpiece or filler use)
- Shipping life (need for preservatives, temperature requirements, ethylene tolerance)
- Vase life
- Harvest (timing and duration)
- Production methods (green house or open field)
- Hardiness
- Pest and disease tolerance
- Uniqueness

3. SOME NEW GENERATION CUT FLOWER CROPS

I. SUGAR BUSH

Family: Proteaceae

Origin: South Africa and Australia

Horticulturally Important Genera: *Protea*, *Leucadendron*, *Leucospermum*, *Banksia*, *Serruria*, *Isopogon*, *Telopea*, and *Macadamia*

The Proteaceae of Southern Africa offers an intriguing floriculture product that can be commercially utilized as a cut flower and as a centerpiece⁵. A convenient taxonomic characteristic of the family is that there is no distinction between the sepals and petals of the flowers. The perianth consists of a single group of four segments referred to as tepals. The most common type of flower head is the capitulum, where the flowers grow on a flat or pointed receptacle. The flowers, which come in varying shades of light pink, pinkish-red, and white, are predominantly oval-shaped and large. The main advantage of *Protea* flowers is their conspicuous and showy nature, which renders them ideally suited as standard blooms that form the focus or centerpiece of large floral arrangements⁶ (Fig 1).

Climate and Soil: Proteas prefer a mild Mediterranean climate with low humidity. They can withstand mild frosts, although the tender leaves and blooms of certain species like *P. nerifolia* and *P. cynaroides* may experience slight damage. *Leucadendrons* and *Leucospermums* are generally unaffected by high summer temperatures. However, persistent high temperatures can harm blooming Proteas, though providing sufficient irrigation can help minimize the damage.

For the best growth and yield, these plants necessitate deep, well-draining sandy soil that has a pH ranging from 5.0 to 6.0. It is advisable to steer clear of alkaline soils for most species. A site with low phosphorus levels, around 20 mg/kg of soil, is preferred⁷.

Post-harvest handling: Flowers are cut preferably in the morning or late afternoon when they are fully mature and remain in good condition for upto 4 weeks, depending upon the cultivar. Long vase life coupled with the unique beauty and hardiness of *Protea* flowers makes them valuable as cut flowers⁸. Proteas usually have a vase life of three to four weeks, but their longevity is decreased to around one week due to postharvest leaf blackening caused by the oxidation of phenolic compounds in the leaves⁹. This can be delayed or eliminated by removing the inflorescence, exposing the flowers to high-light conditions, or girdling the stem immediately below the inflorescence¹⁰. Proteoid roots have been found in all studied species, across a minimum of ten genera¹¹. The optimum stage of harvest for most *Protea* is the so-called soft-tip stage when bracts have lost their firmness and begin to loosen but still adhere (Fig 2). To delay leaf blackening, it is advisable to dip the cut stems of the *Protea* in sucrose solution (1%) or a floral preservative solution both before and after packing¹².

II. ZINGIBERACEOUS CUT FLOWERS

Scientific Name(s): *Alpinia purpurata*, *Zingiber spectabile*, *Etlingera elatior*, *Hedychium* spp.

Family: Zingiberaceae

Origin: Southeast Asia

Other Names: Red ginger, Beehive ginger, Torch ginger, Butterfly ginger, Peacock ginger

Spectacular, brightly colored flowers are a characteristic feature of the ornamental ginger family belonging to the tropical and subtropical regions. Although flowering is better under sunny conditions; however, there are certain varieties that prefer shadier conditions that perform best indoors. The two most important genera of the family Zingiberaceae are *Etlingera* and *Zingiber*, the species of which are examples of exotic tropical flowers that present interesting features that led several producers and nationals to market them as cut flowers and as plants for landscaping¹³ (Fig 3). Ornamental gingers, which are part of the Zingiberaceae and Costaceae families, are considered highly promising for ornamental purposes in the tropical floriculture industry. They can be used for landscaping, as well as for cut flowers and potted plants because of their attractive flowers and foliage¹⁴. Certain species, like *Zingiber spectabile* Griff, *Alpinia*, and *Costus*, are visually appealing because of their foliage or flowers and are frequently utilized as cut flowers¹⁵. Ornamental gingers are favored for cut flowers and potted plants due to their unique leaves, vibrant and colorful bracts that last a long time, and minimal pest issues¹⁶.

i. ALPINIA: *Alpinia purpurata* is one of the species cultivated for its attractive and long-lasting flowers¹⁷. These gingers need warm temperatures for good growth but are susceptible to frost. While it prefers fertile and moist environments, it can also thrive in arid regions sparsely. Post-harvest vase life is reported to be around 10-16 days but it has been reported that flowers with thicker stems have more life. The best time to harvest is when about ½ to ⅔ of the bracts have opened. To prevent bract discoloration, it is advisable to hold the flowers above 10°C (preferably, 15°C and high humidity)¹⁸. To prolong postharvest life, the use of floral preservatives with 2% sucrose and 8-HQC (8-hydroxyquinoline citrate), anti-transpirants, or recutting of stems is practiced¹⁹.

The longest vase life (11.6 d) of red ginger (*Alpinia purpurata* (Vieill.) K. Schum) was recorded when the flowers were held in 0.1% ascorbic acid while the shortest vase life was recorded in control flowers (8 d)²⁰.

ii HEDYCHIUM: *Hedychium coronarium* flowers are consumed as a vegetable, worn as garland in Hawaii and Japan, and used as a source of perfume²¹. The name, 'butterfly ginger' is used to describe the flower's resemblance to a butterfly and its capacity to attract butterflies and moths, which is observed in numerous species¹⁸. In Hawaii, supplementary lights are used for the commercial production of flowers during winters, which suggests that *H. coronarium* is a long-day plant²². Presently, fresh-cut stems are harvested when the buds just begin to open and show color²³.

iii ETLINGERA: The most extensively cultivated species of the genus is *Etlintera elatior* (formerly *Phaeomeria* or *Nicolaia*) which is used for various purposes such as cut flowers, in the landscape and as a vegetable (the young inflorescence). It is propagated by seed or by division of the rhizome mass. A rather long vase life of about two weeks after full bloom has been recorded in torch ginger inflorescence. It was also reported that sucrose in the holding solution improves the water absorption by the stems but it caused some bract browning²⁴. Because of the large size and heavy weight of *E. elatior* inflorescences, it is difficult to ship them without damage to the bracts and hence, the vase life is only 4-5 days before the onset of discoloration¹⁸. A study evaluated four floral developmental stages of torch ginger inflorescences under *in situ* conditions²⁵ (Table 1). The stage at which inflorescence had a maximum of 10 involucre bracts in two layers which were light red pink to red pink in color was considered as the 25% life stage. More than double the number of involucre bracts were recorded in the 50% inflorescence stage as compared to the 25% stage. Dome-like cones (floral bracts) on the top of the waxy involucre bracts appeared in the 75% stage. The appearance of true florets determined the fully opened stage (100%).

iv ZINGIBER: While the immature buds of *Zingiber mioga* are consumed as vegetables, *Z. officinale*, *Z. spectabile* and *Z. zerumbet* are more widely grown for their green inflorescence which is used as cut flowers. At least nine weeks of consecutive short days are required by *Zingiber spectabile* in order to initiate and develop flowers; indicating that it is a short-day species²⁶. They are primarily propagated by division of rhizome or by seed. The floral stems of ice cream can be harvested from the point at which the inflorescences have a diameter greater than the length or when they are long, longer than the diameter. It has been reported in various studies that the postharvest vase-life of *Z. spectabile* ranges from 10 to 15 days¹³.

Various developmental stages of inflorescence development in *Zingiber officinale* were studied¹⁵. Stage 1 of the inflorescence development appeared during the end of January to early February and progressed for $\pm$ 2-3 weeks before the inflorescence reached stage 2. Stage 3 followed $\pm$ 4 weeks after stage 2 (when the bracts were fully open) by the end of March. The whole development of the inflorescence from stage 1 to stage 5 lasted about 13-17 weeks (Table 2).

III. ORNAMENTAL CURCUMA

Scientific Name: *Curcuma alismatifolia*

Family: Zingiberaceae

Origin: Thailand

Other Names: Queen Lily, Siam Tulip

The flowers of the Curcuma family are highly intriguing and distinctive. They come in a variety of sizes, shapes, and colors.

Curcuma alismatifolia is a new flower crop with potential for expansion in the markets. The upper part of the inflorescence contains several pink coma bracts, while the lower part has green coma bracts, with small true flowers (Fig 4).

Propagation is through rhizomes and several storage roots termed as t-roots. Most species prefer fertile, well-drained soil with partial to full sunlight and humid environments¹⁸. It was observed that the flowering of *Curcuma alismatifolia* was enhanced when the plants were subjected to a day length of 20 hours, indicating that it is a quantitative long-day plant²⁷. The plants are propagated through rhizomes with storage roots (ball-shaped)²⁸. Curcuma species or cultivars that have showy bracts and a long post-harvest vase-life are used as cut flowers, while some dwarf forms are used as potted plants²⁹.

IV. KANGAROO PAW

Scientific Name: *Anigozanthos* spp., *Macropidia* spp.

Family: Haemodoraceae

Origin: Australia

Other Names: Kangaroo Paw, Cat Paw Flower, Black Kangaroo Paw

The availability of a wide array of colors has contributed to the growing demand for the genus in the global market for cut flowers³⁰ (Fig 5). Flower evocation is directly related to the temperature, as temperatures rise, more flowers appear³¹. While planting, the spacing is usually kept 50-75 cm between plants and 100-140 cm between rows. The propagation of *Anigozanthos* is mainly through seeds, the germination being usually low. Only three seeds per capsule are found in the genus *Macropidia* and germination is difficult. For both genera, division of the rhizomes is also utilized for propagation³². *Anigozanthos* is usually harvested when two lower florets on the spike open. Poor storage potential is a negative feature of cut kangaroo paw (*Anigozanthos* spp.) inflorescences. Cut kangaroo paw flowers can be safely stored at a range of 2-5°C³³.

V. BAT LILY

Scientific Name: *Tacca integrifolia* and *Tacca chantrieri*

Family: Dioscoreaceae

Origin: Southeast Asia, India and southern China

Other Names: White Bat flower, Black Bat flower, Cats Whiskers, Devil Flower, Jews Beard, Voodoo Flower

Taccas are renowned for their strange, yet entrancing flowers which have long 'whiskery' bracts that can grow up to a foot long. The unique flower morphology and shade tolerance make this plant a promising candidate for cultivation as an indoor, flowering ornamental plant³⁴. The flowers smell like rotting meat and attract flies as pollinators. For producing cut flowers with longer flower stalks, a shade level of 30% was found most suitable³⁵. The bat plant grows in moist and shaded places. Bat flowers are commonly propagated through the division of tuber or rhizome and occasionally from seed. All black bat flower plants grow very well in containers, indoors or on the patio. Bat flower seems to be mostly pest and disease-free; although snails and slugs do occasionally bother it³⁶.

Not many post-harvest studies have been done on bat flowers yet, but it holds a great potential to be used as a cut flower and as a pot plant. The inflorescence traits of *Tacca* spp. (*T. integrifolia* and *T. chantrieri*) were studied to underline the phenotypical differences between the inflorescences of both species³⁷. The former has bracts of white color and long, whiskery bracteoles reaching up to a length of 37 cm whereas *T. chantrieri* has green or purplish colored bracts and the bracteole length

is upto 30 cm. Both these species are extremely suitable to be used as cut flowers and pot plants (Table 3, Fig 6).

VI. GUZMANIA

Scientific Name: *Guzmania* spp.

Family: Bromeliaceae

Origin: Central and South America

Other Names: Scarlet Star

Guzmanias produce showy and long-lived inflorescences. What is commonly misidentified as the flower on the plant is actually a cluster of modified leaves, called bracts. The true flowers remain hidden below the colorful bracts and are white in color (Fig 7). *Guzmania* typically displays colors that range from yellow to orange, although it can also exhibit fiery shades of red or reddish-purple³⁸. They can also be advantageously grown as pot plants for greenhouse or home use. Bromeliads are well established in the flowering potted plant industry, with 60 million plants sold each year as ornamentals out of which 65% are *Guzmania* hybrids. Predominantly, guzmanias are epiphytic plants; however, a few terrestrial species are also reported³⁹. The plants are propagated asexually through the use of tissue culture practices. Also, the off-shoots produced by the plant can be used for propagation. The resulting plantlets produced after the rooting of off-shoots are detached from the mother plant and may be potted up in a suitable growing mixture. In *guzmania* cultivation, tubing is a problem related to water uptake which causes great economic losses. Leaves of some plants attain a twisted, upright shape of leaves, instead of adopting the typical open bromeliad rosette, which makes up to 10% of the plants unsuitable for sale. Little is known about the mechanism and factors leading to tubing. Pre-storage spray with 60 μ M BA could significantly improve the post-storage quality or post-shipment quality of *Guzmanias*⁴⁰.

Guzmanias are susceptible to elevated CO₂ levels. *Guzmania* plants were grown at ambient and elevated CO₂ levels and evaluated. At the end of the experiment a definite higher value for fresh and dry weight was recorded for the CO₂-treated *Guzmania* 'Hilda' plants. In comparison with ambient-grown plants an increase of 57% in fresh weight and 69% in dry weight was found for plants under elevated CO₂⁴¹ (Table 4).

VII. WAX FLOWER

Scientific Name: *Chamelaucium uncinatum*

Family: Myrtaceae

Origin: Western Australia

Other Names: Geraldton Wax

Because of its attractive flowers and long post-harvest life, the wax flower is a popular choice among consumers as a cut flower. Flower colors from white through to purple/red are known (Fig 8). In areas of Western Australia where it has spread beyond its native range, this plant is considered an environmental weed. A highly ornamental yet hardy foliage plant. Although used as filler in flower arrangements, Geraldton wax flower makes a striking display alone⁴². Wax flower tolerates a wide range of conditions. In high rainfall areas, the plants may suffer from botrytis flower blight⁴³. Harvesting of the wax flower is very labor intensive, as stems are cut by hand, when the number of flowers open is between 30-70%, depending on variety, time of the season and market requirements⁴⁴.

4. DISCUSSION

The cultivation of ornamental plants is a rapidly evolving and financially rewarding area within the field of plant production. In 2019, the global flower market, as observed on the largest

flower exchange, Royal FloraHolland, was valued at 4.8 billion euros⁴⁵. The strength of the floriculture market industry resides in the diverse range of products available for sale. That's why it is crucial to continually introduce novel species and cultivated varieties. On a global scale, the market for lesser-known tropical flowers is relatively limited, accounting for around 4% of the total volume of traded cut flowers⁴⁶. The primary origin of these crops can be traced back to South Africa, Asia Australia, and America. Nevertheless, a number of marketing professionals believe that the lesser-known tropical flowers possess untapped potential for market expansion and diversification, with a vision that these flowers fetch higher prices in the market. On the other hand, customers in temperate countries often perceive these products as "unique" and "exotic". With effective marketing strategies and consumer education, there is a promising potential to enhance their consumption in such regions. These particular plant species are abundantly found in local regions of developing countries but are globally scarce. Moreover, there is a lack of comprehensive scientific information and knowledge about them, and their current utilization falls short of their significant economic potential making these plants to be 'lesser-known' and 'under-utilized'.

5. FUTURE SCOPE

Despite being acknowledged as commercially important, these lesser-known ornamental plants are not fully utilized due to limited knowledge about their planting materials and cultivation methods. As a result, it is crucial to draw attention to the implications and potential uses of these overlooked plant species. When marketed alongside conventional flower crops, these plants may contribute to enhanced income for farmers by ensuring market diversification. In recent years, the rising desire among consumers for flowers that are versatile, durable, and affordable has driven the market to continually search for new products. As a result, new flower varieties are introduced every year, which helps to keep the flower market fresh and up-to-date. The novelty in the market can not only be achieved by the introduction of exotic germplasm, but also by the introduction of indigenous and wild ornamentals and also by the development of new varieties of the already existing ornamental germplasm in the country. Therefore, promotion of the cultivation of these crops, improvement of their beneficial traits and optimizing their storage and post-harvest handling operations can serve as a roadmap to ensure higher economic returns. This can be done through:

- A. Introduction and acclimatization of new cut flowers.
- B. Providing research support on new cut flowers.
- C. Exploration and exploitation of indigenous new ornamentals.
- D. Collection of information on consumer attitudes that influence floral purchasing
- E. Prioritizing coordinated well-focused research programs and policies for the development of new crops.

Hence, these lesser-known, underutilized flower crops are the future of the floriculture trade. Therefore, efforts should be made to investigate ways to enhance the worth of these crops and promote their widespread cultivation which would improve livelihood opportunities, particularly for small-scale farmers in less favorable regions of the country.

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7. Conflicts of Interest

The authors declare no competing interest

Author Contributions

Writing - original draft, preparation (DC, AA); Conceptualization and supervision (DC, BK, RS, AA); Data compilation and Arrangement (DC, BK, AA); Reviewed the write-up; Helped in finalizing the draft (DC, BK, RS and AA).

Table 1: Some in situ characteristics of four inflorescence stages of torch ginger (*Etlingera elatior*)²⁵

Characteristics	Degree of opening of inflorescences			
	25	50	75	100
Layers of involucre bracts	2	4	4	5-6
Involucre bracts flexed	Upto 10	11-24	25-43	44-56
Days to reach the stage	9	17	21	25
Appearance of cone (floral bracts)	Covered by involucre bracts	Covered by involucre bracts	Present	Present and distinct
Appearance of true florets	Absent	Absent	Absent	Present

Table 2: Inflorescence development of *Zingiber spectabile*¹⁵

Stage	Characteristics	Time	Inflorescence size (mm)		Notes
			Length	Diameter	
1	Opening of Bracts	6 weeks after spike emergence	39.7±20.7	36.6±18.5	The bract color was pale yellow
2	More opening of bracts	2-3 weeks after stage 1	70.7±24.7	062.0±9.8	The bract color changed to yellow
3	Bracts fully opened	4 weeks after stage 2	101.9±21.2	70.9±5.7	Around March; the first flowers opened
4	Bracts color changed to reddish	4-5 weeks after stage 3	134.7±20.6	74.9±4.1	Opened flowers up to the middle of the bracts
5	The bracts color changed to bright red	3-5 weeks after stage 4	134.7±20.6	75.2±3.9	No more flowers opened

Table 3: Inflorescence traits of *Tacca* species³⁷

Species name	Involucre bract length (cm)			Involucre bract width (cm)			Bract size (length x width) (cm)	Bract color	Bracteo-les number	Bracteo-les length (cm)
	Max	Min	Avg	Max	Min	Avg				
<i>T. integrifolia</i>	10	12	11	6.5	6.8	6.75	74.25	White	22	37
<i>T. chandleri</i>	2.5	10	6.25	1.5	9	5.25	32.81	Green/Purple	21	30

Table 4: Effects of elevated CO₂ on growth and morphological characteristics of *Guzmania* cv. 'Hilda'⁴¹

	380 ppm	750 ppm
Fresh weight (g)	68±14	107±16
Dry weight (g)	9±2	16±3
Number of leaves	23±2	25±2

Table 5: Characters of New Generation Cut Flowers

	Sugar Bush	Zingiberaceous cut flowers	Ornamental curcums	Kangaroo Paw	Bat lily	Guzmania	Wax Flower
Nativity	South Africa	Asia	Thailand	South-West Australia	South-East Asia	Tropical America	Western Australia
Major producing countries	Australia, South Africa	Hawaii	Thailand, Israel	Australia, Israel	-	America, Brazil	Israel
Overall attractiveness as a cut flower	Showy blooms having long vase-life coupled with its use as a dry flower	Erect spikes with attractive red or pink bracts	Tulip-shaped inflorescence with spirally arranged and closely overlapped bracts	Distinct tubular shape covered in dense hairs, opening with six claw-like structures at the top	Broad, wing-like bracts and numerous long, whisker-like bracteoles create a bat-like appearance	Vividly hued bracts surround the flower in a funnel-shaped rosette	Attractive waxy flowers which are aromatic
Flower color and its range	Pink and white to red	Red and orange to yellow and blue	Pink, orange, yellow, and white	Green, Orange, Pink, Purple, Red, White, Yellow	Purple-red to brown	Yellow, red, white, pink, purple, or variegated	White, light pink, dark pink, deep purple and deep red
The potential for use	Centerpiece	Cut flower, Pot plants, landscape use	Cut flower, Pot plants, landscape use	Cut flowers, Pot plants	Pot plants	Pot plants	Filler
Production methods (greenhouse or open-field)	Open-field	Open-field conditions in partial shade	Open-field	Open-field	Open-field	Greenhouse	Open-field

Hardiness	Generally hardy but should be protected from frost	Lacks tolerance to frost and cold; hence should be planted in warm, humid climates	Winter hardy, can be grown in frost-free climates	Does not bear cold	Cannot tolerate frost	Tolerant of temperature variations, can survive in light frost; needs high humidity	Relatively hot cold and drought-tolerant; cannot tolerate cold, harsh winds
Pest and disease tolerance	Most commercial cultivars are pest-free.	No significant reports of pests or diseases	Not bothered by many pests, but slugs and snails may sometimes cause trouble	Notably disease-free; the sole pests encountered are snails and slugs.	No serious insect or disease problems	Leaf spots, scales, spider mites and mealy bugs are the main problems	Relatively pest and disease-free. Though Botrytis and nematodes can cause trouble
Harvest (timing and duration)	Harvested when the plants attain an age of three years, for every two to three days, early in the morning	The flowers are harvested with a long stalk of 50-80 cm in length in the morning or late evening	Harvested 12 weeks after planting	Export: 1-3 individual flowers open per stem; the top part of the stem firm. Domestic: at least 5 flowers open	The flowers should be left on plants as they do not survive in a vase for long	The bloom is harvested at its base close to the cup; may be used in bouquets and flower arrangements	Harvested when 25-80% of the flowers are open
Shipping life (need for preservatives, temperature requirements, ethylene tolerance)	To delay leaf blackening, the cutstems are placed in 1% sucrose or a floral preservative solution	Floral preservatives containing 2% sucrose and 8-HQC and recutting the stems are used to increase the post-harvest life	The flowers are chilling-sensitive, hence cannot be stored dry but they can be stored in water at 7 °C for about 6 days	Flowers wilt rapidly after harvest. Therefore, they should be placed immediately in the water	Stored and transported at slightly high temperatures (12-15°C) like other tropical plants	Should be shipped at a temperature of 15°C for a period of 3 days	Treating flowers with 1-MCP at 200 nL/L can prevent ethylene-induced flower abscission
Vase life	3 to 4 weeks	Upto 9 days	Upto 2 weeks	5-8 days	-	-	7-14 days
Uniqueness	The conspicuous & showy nature of flowers render them ideal as standard blooms	Gorgeous, sweet-scented flowers give an exotic appearance to the landscape	Exquisite tropical plants with distinct, pine-cone-shaped flowers in vivid and vibrant colors	Woolly, tubular flowers, which open to look like a kangaroo's curved fingers	A striking purple-black inflorescence with wide-spread wings and whisker-like bracts.	Brightly colored bracts that grow from an exquisite rosette make it a stunning potted plant	Glossy, berry-like buds arranged in open sprays unfold into lush clusters of waxy star-shaped flowers

Figure 1: Commercially important *Protea* spp.Kingprotea (*Protea cynaroides*) Leucospermum cordifolium Leucadendron laurifolium

Banksia spinulosa Grevillea banksii Isopogon cuneatus

Telopea speciosissima Blushing bride (*Serruria florida*)Figure 2: Post-harvest handling of *Protea* spp.

Figure 3: Commercially important ornamental gingers

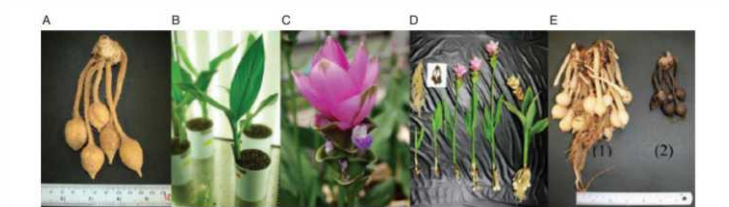
a) and b) *Alpinia* spp. c) *Hedychium* spp. d) *Zingiber spectabile* e) *Etlingera elatior*Figure 4: Different developmental stages of *Curcuma alismatifolia*

Fig. 1. Photographs of curcuma development stages: first shoot development (stage 1), first inflorescence fully open (stage 2), late flowering (stage 3) and harvest (stage 4). A: Planting organ is an old rhizome with storage roots (ball shape) (0 weeks). B: Plant at stage 1 (10 weeks). C: Inflorescence at stage 2 (13 weeks). D: Whole plant at stage 3 (21 weeks). E: Plants at harvest stage 4 (32 weeks). (1E) new storage organs are new rhizomes and storage roots originating from one old storage organ (2E) old storage organ.

Figure 5: Flowers of *Anigozanthos* spp.Figure 6: Flowers of a) *Tacca integrifolia* and b) *Taccachantrieri*Figure 7: Different types of *Guzmania* hybridsFigure 8: *Chamelaucium uncinatum* flowers

REFERENCES

- Kumar MS, Jawaharlal M, Ganga M and Surendranath R (2012, September) Novel ornamental plant species for the ornamental industry. In: International Conference on Agricultural & Horticultural Sciences held at Hyderabad, India. 2012, 145p. [\[Link\]](#)
- Noordegraaf CV (1999) An approach to select new ornamental crops. In: IV International Symposium on New Floricultural Crops 541:75-78. [10.17660/ActaHortic.2000.541.9](#)
- Anonymous (2024) Area and Production of Horticulture crops for 2023-24 (Final). Ministry of Agriculture and Farmers Welfare. New Delhi, India. [\[Link\]](#)
- Weiss D (2002) Introduction of new cut flowers: domestication of new species and introduction of new traits not found in commercial varieties. In: Breeding for Ornamentals: Classical and Molecular Approaches, Springer, Dordrecht. pp 129-137. [\[Google Scholar\]](#)
- Littlejohn GM (2001, July). The challenges of breeding wild flower cultivars for use in commercial floriculture: African Proteaceae. In: XX International Eucarpia Symposium, Section Ornamentals, Strategies for New Ornamentals-Part 1552:25-38. [10.17660/ActaHortic.2001.552.2](#)
- Coetzee JH, Littlejohn GM (2001) Protea: a floricultural crop from the Cape Floristic Kingdom. In: Proteaceous ornamentals: Banksia, Leucadendron, Leucospermum and Protea. Belgium: Scripta Horticulturae 77-105. [https://doi.org/10.1002/9780470650806.ch1](#)
- Leonhardt KW, Criley RA (1999) Proteaceae floral crops: cultivar development and underexploited uses. In: Perspectives on new crops and new uses ASHS Press, Alexandria, VA, pp 410-430. [\[Link\]](#)
- Sheela VL (2008) Flowers for trade (Vol. 10). New India Publishing, New Delhi, India, 282p [\[Google Scholar\]](#)
- McConchie R, Lang NS, Gross KC (1991) Carbohydrate depletion and leaf blackening in *Protea neriifolia*. J Am Soc Hortic Sci 116:1019-1024. [https://doi.org/10.21273/JASHS.116.6.1019](#)
- Reid MS, Doorn WV, Newman JP (1998, March) Leaf blackening in proteas. In: IV International Symposium on Postharvest Physiology of Ornamental Plants. pp. 81-84. [10.17660/ActaHortic.1989.261.9](#)
- Lamont BB (1985, August). The significance of proteoid roots in proteas. In: I International Protea Research Symposium 185:163-170. [10.17660/ActaHortic.1986.185.17](#)
- Brink JA, de Swardt GH (1986) The effect of sucrose in the vase solution on leaf browning of *Protea neriifolia* R. Br Acta Hortic 185:111-119. [10.17660/ActaHortic.1986.185.11](#)
- Loges V, Costa AS, Guimaraes WNR, Teixeira MDCF (2008) *Etlingera* spp. and *Zingiber spectabile* market potential. Rev Arms Hortic Ornament 14:15-22. [\[Link\]](#)
- Marques DJ, Bianchini HC, de Souza AP (2019) Nitrogen fertilization on ornamental ginger under fertigation in protected cultivation. Hort Bras 37:146-151. [https://doi.org/10.1590/S0102-053620190204](#)
- Palupi ER, Adriyani DH, Tjong M (2019) Flowering and Reproductive Biology of *Zingiber spectabile*. Pertanika J Trop Agric Sci 42:1375-1389. [\[Link\]](#)
- Paz MDP (2003) Rhizome manipulation affects growth and development of ornamental gingers. MSc. Thesis. Louisiana State University and Agricultural and Mechanical College. 603p. [10.31390/gradschool_theses.603](#)
- Sirat HM, Liamen MR (1995) Chemical constituents of *Alpinia purpurata*. Pertanika J Sci Tech 3:67-71. [\[Link\]](#)
- Criley RA (2014, August) Alpinia to Zingiber-Zingiberales in commercial floriculture. In: XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC 2014). pp 435-454. [10.17660/ActaHortic.2015.1104.64](#)

19. Kobayashi KD, McEwen J and Kaufman AJ (2007) *Ornamental ginger, red and pink*. Ornamentals and Flowers, Cooperative Extension Service, University of Hawaii, Honolulu, HI, USA. pp 1-8.[\[Link\]](#)
20. Ieamtim P, Buanong M, Kanlayanarat S (2007, December) Role of ascorbic acid on vase life of red ginger (*Alpinia purpurata* (Vieill.) K. Schum). In: Europe-Asia Symposium on Quality Management in Postharvest Systems - Eurasia. pp 287-290.[10.17660/ActaHortic.2008.804.39](#)
21. Chan EWC, Wong SK (2015) Phytochemistry and pharmacology of ornamental gingers, *Hedychium coronarium* and *Alpinia purpurata*: A Review. *J Integr Med* 13:368-379.[https://doi.org/10.1016/S2095-4964\(15\)60208-4](#)
22. Agboka D, Criley RA (2002) Control of vegetative growth and flowering in white ginger *Hedychium coronarium* Koenig. *Bull Heliconia Soc Intl* 10:7-8.[\[Link\]](#)
23. Maree J and van Wyk BE (2010) *Cut Flowers of the World*. Timber Press, London, 400p.[\[Google Scholar\]](#)
24. Choon SY, Ding P (2012) Sucrose affects postharvest characteristics of torch ginger (*Etlingera elatior*) inflorescence. *Acta Hortic* 1012:581-587.[10.17660/ActaHortic.2013.1012.78](#)
25. Bayogan ERV, Grauto MBB (2013, December) Vase life of torch ginger (*Etlingera elatior*) inflorescences as influenced by harvest maturity and 1-Methylcyclopropene. In: Proceedings of 11th Southeast Asia Symposium on Quality Management in Postharvest Systems. pp 313-317.[10.17660/ActaHortic.2015.1088.52](#)
26. Criley RA (2011) Response of *Etlingera corneri* and *Zingiber spectabile* to photoperiod. *Bulletin of Heliconia Soc Intl* 17:1-3.[\[Google Scholar\]](#)
27. Hagiladi A, Umiel N, Yang X H (1996, March) *Curcuma alismatifolia*. II. Effects of temperature and daylength on the development of flowers and propagules. In: VII International Symposium on Flower bulbs. pp 755-761.[10.17660/ActaHortic.1997.430.120](#)
28. Khuankaew T, Ohyama T and Ruamrungsri S (2009) Effects of ethephon application on growth and development of *Curcuma alismatifolia* Gagnep. *Bulletin Fac Agric Niigata Uni* 62:9-15.[\[Link\]](#)
29. Roh SM, Lawson R, Suk LJ, Suh KJ, Criley AR, Apavatjirut P (2006) Evaluation of Curcuma as potted plants and cut flowers. *J Hortic Sci Biotechnol* 81:63-71.[https://doi.org/10.1080/14620316.2006.11512030](#)
30. Teagle S, White J, Sedgley M (1991) Post-harvest vase life of cut flowers of three cultivars of kangaroo paw. *Scie Hortic* 48:277-284.[https://doi.org/10.1016/0304-4238\(91\)90136-M](#)
31. Hagiladi A (1982) The influence of temperature and daylength on growth and flower yield of *Anigozanthos manglesii* (Haemodoraceae). *Acta Hortic* 134:49-56.[https://doi.org/10.21273/HORTSCI.18.3.369](#)
32. McComb JA, Newton S (1981) Propagation of kangaroo paws using tissue culture. *J Hortic Sci* 56:181-183.[https://doi.org/10.1080/00221589.1981.11514986](#)
33. Joyce DC, Shorter AJ (2000) Long term, low temperature storage injures kangaroo paw cut flowers. *Postharvest Biol Technol* 20:203-206.[https://doi.org/10.1016/S0925-5214\(00\)00123-X](#)
34. Krisantini AWM, Palupi ER (2007) Evaluation of horticultural traits and seed germination of *Tacca chantrieri* 'André'. *Agricul Nat Resour* 51:169-172.[https://doi.org/10.1016/j.anres.2016.12.006](#)
35. Abdullah TL, Misrol MZ, Stanslas J, Abd Aziz M, Goh LP (2014) Effect of shade and morphological characterization of Janggut Adam (*Tacca* sp.) as a promising native ornamental and medicinal plant. *Inn Plant Product Qual* 22:13-15.[\[Google Scholar\]](#)
36. Norzielawati S, Kiew R, See LS (2017) *Tacca integrifolia* Ker-Gawl. *MyBISp* 1-3.[\[Google Scholar\]](#)
37. Paz MDP (2003) Rhizome manipulation affects growth and development of ornamental gingers. MSc. Thesis. Louisiana State University and Agricultural and Mechanical College. 603p.[10.31390/gradschool_theses.603](#)
38. Bak GJ, Steur ND, Bak E (1998) *Guzmania* plant named Rumba. U.S. Patent 08/813,179.[\[Link\]](#)
39. Bak GJ, Steur ND, Bak E (1994) *Guzmania* plant named Pax. U.S. Patent 08/183,041.[\[Link\]](#)
40. Chen C, Yeh D, Lin T (2011) Effects of chemical treatments on post storage quality of potted *Guzmania* (*Guzmania lingulata* Mez. 'Cherry'). *J Taiwan Soc Hortic Sci* 57:183-195.[\[Google Scholar\]](#)
41. Vanhoutte B, Ceusters J, de Proft MP (2016) The 'tubing' phenomenon in commercial cultivation of *Guzmania*: morphology, physiology and anatomy. *Scie Hortic* 205:112-118.[https://doi.org/10.1016/j.scienta.2016.04.008](#)
42. Joyce DC (1983) Postharvest floral organ fall in Geraldton waxflower (*Chamelaucium uncinatum* Schauer). *Aust J Exp Agri* 33:481-487.[https://doi.org/10.1071/EA9930481](#)
43. Grown D (1995) Waxflower for cut flower production. *Agri West Aust Farmnote* 86/95.[\[Google Scholar\]](#)
44. Shillo R, Ronen A, Mathan E, Moldavsky R (1996, March) Advancing and spreading out flowering of out-door cultivation in the Geraldton wax flower by short day treatment. In: IV International Protea Working Group Symposium held at Ben-Gurion University of the Negev, Israel. 453:61-68.[10.17660/ActaHortic.1997.453.6](#)
45. Salachna P (2022) Trends in ornamental plant production. *Horticultrae*, 8: 413p.[https://doi.org/10.3390/horticultrae8050413](#)
46. Zhang L, Li HT, Gao LM, Yang JB, Li DZ, Cannon CH, Chen J, Li QJ (2011) Phylogeny and evolution of bracts and bracteoles in *Tacca* (Dioscoreaceae). *J Integr Plant Biol* 53:901-911.[https://doi.org/10.1111/j.1744-7909.2011.01076.x](#)