Plant Archives Vol. 25, Supplement 2, 2025 pp. 2492-2501 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.317

PETALS TO PROFITS: ENHANCING THE COMMERCIAL FLOWERS INTO HIGH VALUE PRODUCTS

Shaik Sumera[1*], R. Chitra[1], M. Ganga[1], A. Ramalakshmi[2], P. Meenakshi[3] and P. Geetha[4]
[1]Department of Floriculture and Landscape Architecture, Tamil Nadu Agricultural University, Coimbatore-641003, India
[2]Department of Food Process Engineering, Tamil Nadu Agricultural University, Coimbatore - 641003, India
[3]Department of Renewable Energy, Tamil Nadu Agricultural University, Coimbatore - 641003, India
[4]Centre for Post Harvest Technology, Tamil Nadu Agricultural University, Coimbatore - 641003, India
[*]Corresponding authors E-mail: sumeras1998@gmail.com
Orcid ID: https://orcid.org/0009-0005-5978-6954
(Date of Receiving : 16-04-2025; Date of Acceptance : 25-06-2025)

ABSTRACT

Floriculture is an emerging branch and it can have a direct impact on agri-businesses as the potential of it is yet to explore. Flowers are directly used for their cut and loose flower purpose; however, there are some value-added products that can cause direct benefit to the flori-enterprises. Value addition of products ensures high returns to the venture and growers, along with offering more satisfactory quality products for the international market. This post-harvest technique of value addition relies upon novelty and the adoption of improved techniques like logistics and marketing. Value-added products from the floriculture sector expand from essential oils, flavours, fragrance, pharmaceutical and nutraceutical compounds, insecticidal and nematicidal compounds, pigments and natural dye, gulkand, rose water, *etc*. Furthermore, emerging approaches such as advanced dehydration techniques for dry flowers, nanotechnology-based preservation methods for cut flowers and the conversion of flower waste into high-value nutraceutical and pharmaceutical products are broadening the scope of value addition in floriculture. These innovations not only enhance product shelf life and quality but also promote sustainable practices and generate rural employment, thereby strengthening the overall agri-business potential of the sector.

Keywords : Cut flower arrangement, Commercial flower, Dry flower, Potential, Tinting, Value addition.

Introduction

Floriculture is an emerging sector in India with the total market value of INR 157 billion in 2018 and this is additionally predicted to reach INR 472 billion by 2024, rising at a CAGR of 20.1% from 2019 to 2024. However, recent data indicates that the Indian floriculture market size attained INR 292.0 billion in 2024. IMARC Group anticipates the market would attain INR 744.0 billion by 2033, demonstrating a compound annual growth rate (CAGR) of 10.9% from 2025 to 2033. While this market holds a prominent position in the global trade, the limitation lies in the perishable nature of the produce which not only limits the global market reach but also reduces profit. Hence, value addition is the way to strengthen the floriculture sector as there is a growing demand of value-added flower products (Mekala *et al.*, 2012), which can be tackled by systematic processing, packaging and supply chain management.

The commercial potential of flowers can be significantly enhanced through value addition and processing, particularly in the nutraceutical and dry flower industries. Flowers are abundant in bioactive substances, vitamins and antioxidants, making them valuable for the nutraceutical sector, which is increasingly recognizing their health benefits (Nagajyothi and Pratheeksha, 2023). Additionally, the dried flower market, which constitutes about 15% of the global floriculture business, has gained traction due to rising demand for eco-friendly products, with

various species like marigolds and chrysanthemums being processed into dried forms for aesthetic and commercial uses (Das and Datta, 2022; Datta and Roy, 2023). Furthermore, the valorization of flower waste, such as marigold by-products, presents opportunities for extracting high-value compounds like lutein, which is in high demand for its health benefits (Chauhan *et al.*, 2022). This multifaceted approach not only promotes sustainability but also supports rural economies by creating employment opportunities in flower processing and craft industries (Das and Datta, 2022; Datta and Roy, 2023).

Value addition in floriculture trade refers to the development of a system or products that can increase its economic value by modifying the manufacturing process, increasing appeal, packaging, year-round availability and introducing novel product according to the market fit. Such a value addition can be further expanded by adopting postharvest technologies and improved logistics. Value addition of several parts of flowers (Figure 1) aids benefit to the growers as it fetches higher price in the market and appeals premium consumers due to its fresh and new properties. For a country like India, which is bestowed with varied agro-climatic conditions, opportunities are blooming as vast number of fresh flower can be obtained and modified according to the global market need and exported to gain higher profit. Value added products like essential oils, attrs, concrete and gulkand are exported from India. Thus, a new expansion of floriculture sector into value addition by creating novel products (Table 1) and preserving the perishable will attract appealing consumers and generate a new horti-venture. Products such as dried flowers, fresh and dry flower arrangements, floral ornaments, floral teas and salads, are in trend in global ventures. Some nutraceutical and pharmaceutical benefits are also there in flowers which can be potentially utilized commercially by value addition and developing several products such as essential oils, flavours, fragrance, insecticidal and nematicidal compounds, pigments and natural dye, gulkand and rose water, *etc*.

Requirement of Value Addition

1. Eco-friendly manner to add value to perishable produces.
2. Increased availability throughout the year.
3. Increased scope of employment.
4. Generation of new and novel products for the market.
5. Reduction in post-harvest losses by 45%.

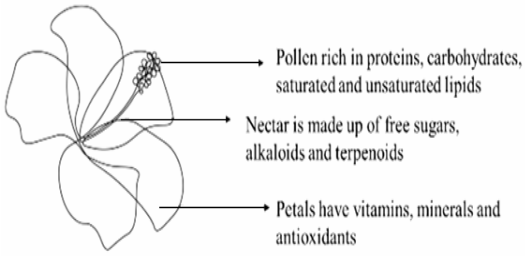

Fig. 1: Beneficial component of flowers based on their parts (Fernandes *et al.*, 2017)

Table 1: Products developed by the processing of commercial flowers

Sl. No.	Product	Flowers used
1	Herbal tea	Chamomile, Butterfly pea, *Hibiscus rosa-sinensis*, Jasmine, *Rosa* spp.
2	Essential Oils	Jasmine, Rose, Michelia, Nyctanthes
3	Salad and Culinary purpose (Edible flowers)	Pansy, Rose, Marigold, nasturtium, lavender, hibiscus
4	Insecticide	Chrysanthemum
5	Dried flowers	Paper flower, Rose, Helichrysum, Corn flower

Fresh Flower Value Addition

Freshly harvested flowers can be added value by converting them into commercial products such as bouquets, garlands, interior decorations, *etc*. Cut flowers as well as loose flowers are used as following.

1. Processed Flower Products

There are wide ranges of food and beverage products that are derived from flowers, include jam, jelly, marmalade and soup, floral teas, syrup, wine, gulkand, edible flowers, petal jam and rose hip juice. Moreover, recent research has explored the utilization of underutilized floral biomass for food product development. For example, the fruits and flowers of *Capparis decidua* have been successfully employed to develop a value-added jam, highlighting an innovative approach to converting floral waste into commercially viable food products (Muzamil *et al.*, 2025).

Furthermore, emerging physical field-based technologies such as ultrasound, microwave and infrared treatments have been explored to enhance the quality stability of edible flower products (Feng *et al.*,

2024). Recent advances in nanotechnology have unveiled new opportunities for enhancing the commercial quality of cut flowers. For instance, studies have demonstrated that composites of multi-walled carbon nanotubes (MWCNTs) combined with gibberellic acid can significantly extend vase life and improve flower quality in roses (El-Naggar *et al.*, 2024). Similarly, the uses of MWCNTs in cut chrysanthemums have been shown to enhance inflorescence development and prolong vase life (Li *et al.*, 2024). These approaches not only reduce postharvest losses but also add value to fresh flower products by maintaining their aesthetic appeal longer.

Floral Teas

Floral teas are the drinks prepared by boiling water with the flowers that makes it full of antioxidants and offers numerous benefits as discussed in Table 2. These drinks are popular as the replacement to the traditional drinks which are loaded with sugars and calories. Floral drinks are offered while visiting the spa, to promote calmness and relaxation, in hotels as welcome drinks, in mocktails and cocktails for infusing bring and rich colours. To prepare floral drinks, simply brew the water with dried flowers and wait for few minutes and strain it. Over boiling of water can result in depletion of nutrients.

Table 2: Benefits of various floral drinks

Sl. No.	Flower	Advantages
1	Blue pea flower	• It is having abundant anthocyanins that are antioxidant compounds responsible for its unique Blue color (Oguis *et al.*, 2019). • It has Ternatins which help to mitigate inflammation and potentially inhibit cancer cell proliferation (Nair *et al.*, 2015). • It may also block the synthesis of fat cells in your body (Kobayashi *et al.*, 2012). • Consumption of blue tea can increase antioxidant levels and reduce blood sugar and insulin levels (Chusak *et al.*, 2018). • It may also be beneficial for promoting hair and skin health (Addor *et al.*, 2017).
2	Chamomile	• Improves the quality of sleep by promoting sleepiness (Chang and Chen, 2016). • Apigenin, an antioxidant in chamomile can prevent cancer (Shukla *et al.*, 2010). • Chamomile tea may lower fasting blood sugar levels (Weidner *et al.*, 2013).
3	Lavender	• Boost mood by produce a calming effect (Koulivand *et al.*, 2013) and promote sleep (Lillehei *et al.*, 2015). • Reduces and soothes menstrual cramps (Nikjou *et al.*, 2016).
4	Hibiscus	• Aids in reducing blood pressure, promotes healthy cholesterol and triglyceride levels, mitigates oxidative stress, decrease the risk of obesity and functions as an antidepressant (Sharma, 2020).
5	Jasmine	• Offers several health advantages, including stress relief, diabetic management and immune system enhancement (Sharma, 2020).
6	Rose	• Possesses antioxidative, anti-allergenic, and anti-inflammatory effects. • Aids in fortifying the immune system, enhancing the digestive system, and alleviating constipation (Sharma, 2020).

Dragon Fruit Flowers

Recent studies have shown that dragon fruit flowers (*Hylocereus* spp.) are valuable enough for value addition because of bioactive activity, rich antioxidant properties and medicinal benefits (Tarte *et al.*, 2023). Some common processing methods like fermentation, drying and extractions can convert dragon fruit flowers into soothing herbal teas, functional food ingredients and dietary supplements.

Edible Flower

As shifting to a healthier lifestyle has been a requirement these days, the introduction of a new healthy culinary item on a plate that serves the purpose will get attention. Edible flowers have consistently been incorporated into the human diet (He *et al.*, 2015) and reports have been documented from ancient Greece and Rome, Europe and Asian countries like Japan and China. Adding flowers to the food can enhance taste and presentation as well as improve texture (Table 3). Along with these, edible flowers can also possess many medicinal properties which are anticancer, anti-inflammatory, antitumor and anti-microbial. Nutritionally flowers also contain high levels of pigments like chlorophyll, carotenoids, xanthophyll and anthocyanin.

Gulkand

Gulkand is a sweet edible culinary made from rose petals that are infused with sugar. The sugar slowly softens the petals tissues and gives a rose-flavoured sweet item which is widely used in food items such as paan, sweets and dry fruits items. This is much popular in India and it is believed to have various medicinal and Ayurvedic properties. In order to prepare gulkand, freshly collected rose petals are washed and separated from flowers by removing the foreign particles. The petals are then dried in sun to remove excess water and collected in glass bottle which is clean and has no moisture as it can evidently ruin the gulkand. Sugar is added in this glass jar with the ratio of 1:1 (sugar to rose petals).

Flowers in the Nutraceutical Industry

Surging demand for nutraceuticals and functional foods has brought flowers into the limelight as potential sources of bioactive molecules. Lavender, hibiscus, rose, calendula and chamomile flowers possess essential oils, polyphenols, flavonoids and antioxidants that are responsible for anti-inflammatory, anti-cancer and cardioprotective effects (Nagajyothi and Pratheeksha, 2023) (Figure 2). The molecules can be extracted and utilized in dietary supplements, tea and pharmaceutical formulations. Additionally, processing technologies such as micronization have been used to improve rose petal antioxidant capacity, thus widening their potential as functional foods (Różyło *et al.*, 2024).

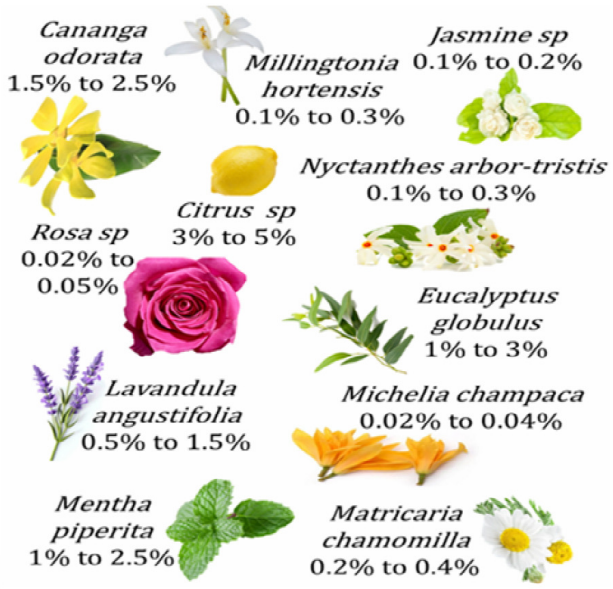

Fig. 2 : Flowers that possess essential oils

Table 3: Commonly used edible flowers (Lu *et al.*, 2015)

Sl. No.	Flowers	Uses
1	*Anchusa azurea*	Soup, boil, fries and salad.
2	*Calendula officinalis*	Salads, omelettes or as an accompaniment cheese.
3	*Hibiscus rosasinensis*	Infusions and food supplement, herbal drinks, fermented drinks, wine.
4	*Rosa chinensis*	Flavour extract, jams and infusions.
5	*Tropaeolum majus*	salads, foodstuffs and drinks.
6	*Viola tricolor*	Food colorants, sweets, salads, soups, vinegars and drinks.

2. Tinting

Tinting is the process of imparting new colour to flowers that are white (no colour) or light in colour. This is a significant value addition to flowers where the market need of variety colours is understood and the novel pigment is enhanced in the flower. This new colour can be introduced in fresh flowers by immersing food colour in the water and allowing the transpiration stream to carry tinted water to the petals.

3. Flower Ornaments

Floral ornaments are generally prepared from loose flowers.

- ***Garlands:*** Garlands are crafted using either a single type of flower or a mixture of other flowers, designed to be worn around the neck, suspended from an inanimate object, or placed in a location of cultural or religious significance.
- ***Floral Ornaments:*** It includes bangles, earrings, crown, Bajubandh.
- ***Corsage:*** It is basically a wrist ornament worn by women that acts like a flower bracelet.
- ***Buttonhole/ Boutonniere:*** It is a single, miniature flower decorative element generally worn by men on the suite during their special day.
- ***Wreath:*** It is a circular ring-like structure made from flowers or foliage intertwined with the help of a wire or support. It is generally placed on a grave as a memorial or worn on the head as a crown or placed on the door hanging for a decorative purpose.

- ***Veni:*** Veni is a kind of floral arrangement where specific flowers such as jasmine, *Nycanthus arbor-tristis*, crossandra or rose are piled in a long thread to place it in the hair of women, this is a common practice followed in the Southern parts of India.

4. Cut Flower Arrangement

Flower arrangement is flourishing in various sectors. Prime sectors being hospitality and floristry, it lays immense scope for creative amateurs and experts to flaunt their creativity. Flowers add beauty to the place, increase its overall ambiance and refresh one's mind. Flower arrangement is broadly classified into 2 types: (i) Western styles of flower arrangement and (ii) Eastern styles of flower arrangement.

Western Styles of Flower Arrangement

The triangular model: It is the most common flower arrangement and as the name suggests it's basically triangular in shape. Flowers and fillers are arranged in such a manner that it attains a triangular shape.

- ***The Round bowl model*:** Also known as the circular shape arrangement. The circular design adds a pleasing element and area satisfying to the viewer's eye. It is one of the easiest flower arrangements, as generally in nature flower bunches are circular in fashion. This arrangement signifies much professionalism and hence it is of prime choice for conference tables or buffet tables.
- ***The Oval bowl model*:** This is a type of horizontal arrangement that consumes a lot of space and gives an illusion of a busy flower arrangement. Flat-laying rectangular pot will fit best in order to achieve this type of arrangement.
- ***The L-shape model*:** It is a type of asymmetrical flower arrangement that is done by giving an L shape with flowers and fillers. The intersection of the horizontal and vertical lines must have a mass effect and the ends must be as tapered as possible by using a low-mass cut flower such as a closed bud or leaves.
- ***The S-shape model*:** The arrangement is very graceful as it gives arches and curves to the overall arrangement. Naturally curved flower sticks are used to make an S-shaped arrangement. Generally, after forming an S shape, gaps are filled with fillers of choice.
- ***The Crescent shape model*:** Just like the name suggests, it is crescent in shape and asymmetrical in shape. It is very eye-catching and requires skills to make one.
- ***Fan shape model*:** In this classic model, the material is arranged in an outward position that resembles just a fan. This type of arrangement mainly focuses on mass and volume.

Eastern Style of Flower Arrangement

- ***Ikebana*:** The word 'ikebana' is derived from '*ikenobo*'. Also known as Eastern, Oriental, Japanese flower arrangement. Its main emphasis is on spiritual and religious background. Ikebana has 3 main axes: Shin (Heaven), Soe (Man), Hike/Tai (Earth).

5. Fresh Flower Decoration

- ***Rangoli:*** It is an attractive pattern drawn and decorated with various coloured flowers at the entrance of the gate. It is usually done during the auspicious gathering or festival to enhance the overall look of the place and induce freshness through flowers.

Dry Flower Value Addition

Dried flowers are basically flowers whose moisture levels have been reduced to a level where they are available throughout the year (Susan, 1990). More than three-fourths of India's floriculture exports comprise dry flowers and handmade botanical items (Daddoras and Datta, 2022). The increasing preference for eco-friendly products has enhanced the importance of dried flowers in the global market, contributing nearly 15% to the global floriculture business. Additionally, research at CSIR-NBRI, Lucknow, has led to advancements in dehydration technology, facilitating the conversion of fresh and waste flowers into valuable products while preserving their aesthetic appeal (Datta and Roy, 2023). Drying is the preservation technique in which flowers can be long stored for their beauty and texture and used for multiple purposes. Drying is not only limited to flowers but plant parts that possess an attractive quality can also be preserved and used to gain income. Drying

also known as dehydration is the process by which the flowers or any plant part such as bark, seeds, pods, or fruit can be retained for a longer period of time along with enhancing its ornamental quality. In contrast to fresh flowers, dry flowers are available year-round with maximum aesthetic value (Jain, 2016).

As the perspective of eco-consciousness is rising, the use of dried flowers and products made from dried flowers has increased and it has become a choice of decoration, gifting and preservation as described in table 4. The product and flower longevity depends upon the type, species and consistency of the flower. The dehydration of flowers mainly involves drying, bleaching and colouring (Lourdusamy *et al.*, 2001).

In India, the export of dry flowers falls ahead of the export of cut flowers, live plants, bulbs, tubers, *etc.* and the top destination of this trade are the USA, The Netherlands, the UK, Germany and United Arab (Apeda, 2017). United States stands first in importing dry flowers worth 61.2 million US$, followed by France (53.6 million US$) and Denmark (28.1 million US$). The demand for dried flowers is rising at a remarkable rate of 8-10% (Pant and Singh, 2023). India has been exported 34,76,469 million MT of dried flowers during 2018; while Spain and Egypt showed significant growth in the import of dried flowers from India by 86.67% and 63.64%, respectively. The major dried products exported from India are lotus pods, Camellia, Dahlia, Bell cups, Marigold, Jute flowers, Wood rose, Wild lilies, Paper flower, *etc*. Tuticorin and Kolkata are the prominent sites of export from India.

Material used for drying: cut flower, foliage, ferns, grasses, sedges, seed pods, flower skeletons; nuts, fruits and cones, barks, branches, lichens and fungus (Shah *et al.*, 2022).

Products: handmade paper, lampshades, candle, bags, photo frames, boxes, books, wall quilts, cards (Shah *et al.*, 2022).

Dried ornamental flowers and the products derived from them may provide qualities, such as novelty, longevity, aesthetic properties, flexibility and year-round availability (Joyce, 1998). Several products like potpourri, floral candle making, press dried flower products like books, photo frames and petal-embedded handmade paper are made (Figure 3).

Fig. 3 : Dry flower products

Table 4: Plants and their plant parts used for dry flower purpose (Sharma, 2020)

Sl. No.	Plant part	Common Name
1	Flower	Rose, Daisy, Helichrysum, Cosmos, Dahlia, Euphorbia, Calendula, Chrysanthemum, Antirrhinum, Candytuft, Marigold, Zinnia, Hollyhock, Poppy, Annual Sunflower, Larkspur, Cornflower, Gladiolus, Gaillardia Gerbera, Heliconia, Lilium.
2	Palm leaves	Datepalm, Cycus, Fishtail Palm, Areca Palm.
3	Weeds	*Leucasaspera*, *Celosia argentiavarspicata*, *Xanthium strumarium*, *Malvapusilla*, *Chloris barbata*, *Parthenium*.
4	Vegetables	Bottleguard, Onion and leafy vegetables.
5	Tree pods	Ficus Species, Semal, Cassia, Gulmohar, Neem.
6	Cereals/ pulses/ oilseeds pods	Maize, Wheat, Rice, Til, Safflower.

Natural Pigments and Dyes

Natural coloring matters are contained in flowers due to the presence of carotenoids, anthocyanins and other color-yielding substances. Carotenoid pigments, specifically lutein and zeaxanthin that originate from marigold flowers are used extensively as natural food colors and antioxidants for use in the nutraceutical market (Chauhan *et al.*, 2022). Marigold derived natural dyes provide a natural substitute for synthetic dyes and therefore are an extremely valuable substance to use in the textile, cosmetic and food industries. For trade, the pigments are removed and used as a dye to dye clothes as per table 5. Some of the dyes are even edible and full of antioxidants which can be consumed as well.

Table 5: Plant species used for dye extraction

Sl. No.	Species	Plant Part used	Colour
1	*Tagetes erecta*	Flower	Yellow
2	*T. petula*	Flower	Brown
3	*Carthamus tinctorius*	Flower	Red
4	*Butea monosperma*	Flower	Yellow, Orange
5	*Bixa orellena*	Pulp (Aril)	Orange, Red
6	*Bauhinia variegata*	Bark	Yellow
7	*Tecoma grandis*	Leaf	Yellow

Insecticidal Properties

Some flowers have compounds that can act as an insecticide for controlling several pests and some of them are listed below in table 6.

Table 6: Insecticidal properties of ornamental flowers

Sl. No.	Flower	Insecticidal properties
1	*Chrysanthemum cinerariaefolium*	Pyrethrum/ Pyrethrins is the compound that acts as an Insecticidal for insects such as cockroaches, ants, mosquitoes.
2	*Azadirachtaindica*	Azadirachtin is the compound and several products of neem such as Neem oil, Neem cake, Neem powder and Bionimbecidine is used to control nematodes, sucking and chewing insect pests.
3	*Lantana camara*, *Tagetes minuta*	Used against malaria vector, *Anopheles gambia*.
4	Roses and rose hips	Acts as antioxidant.
5	*Nerium oleander*	Leaf extract-Larvicidal against the larvae and pupae of *Anopheles stephensi*.

Vermicomposting

The crisis of flower waste is increasing day-by-day and there must be a solution developed. Hence, vermicomposting or composting of flowers can be a sustainable approach to environmental sustainability (Bhati *et al.*, 2021). Vermicomposting can be done by mixing flower waste and dung in 1:1 and *Eudrilus eugeniae* gives maximum efficiency in this ratio. Flower waste, particularly marigold (*Tagetes* spp.), is

commonly discarded after religious and social functions, contributing to environmental waste. However, it has high potential for sustainable utilization. Marigold waste can be used in biogas production, compost preparation and phytoremediation (Chauhan *et al.*, 2022). Furthermore, its carotenoid-rich petals can be processed for lutein extraction, a compound widely used in pharmaceuticals and nutraceuticals. This technology involved the bioconversion of waste flowers into value-added products which can not only reduce the volume of temple-generated floral waste but also provide compost to farmers.

Cosmetics from Flowers

Flowers are widely used in the cosmetic industry owing to the natural antioxidants present in them and its revitalizing and calming effects on the skin. The use of flower extract in the industry is increasing due to the fact that the product developed in this way will be cruelty-free and natural by origin. Generally, botanical products prepared from flower extracts are rich in vitamins, antioxidants, essential oils and oils, hydrocolloids, proteins, terpenoids and other bioactive substances (Dubey *et al.*, 2004). There are some popular brands that have done research and incorporated the flower's potential into their products to increase its efficiency. Cosmetic products like lotion, soap, toner, perfumes, shampoo, mask, face and hand cream, face and body wash has different flower extracts in them which adds value to flowers. Innovative techniques, such as nanofiltration of antioxidant-rich residual water from hydrodistillation of *Rosa damascena* petals, have also been demonstrated as effective for recovering valuable bioactive compounds (Stoyanova *et al.*, 2025).

Conclusion

Value addition in flowers can be a potential solution to the large amount of floral waste that goes to dump due to its perishable nature. There is tremendous scope in floriculture industry to develop products which rely on the natural traits flowers possess such as antioxidants in flowers can be used to develop certain kinds of tea, salads and cosmetics. Insecticidal property for making repellents and finally the organic waste can be converted to the compost which can add value to the soil system. Year round availability can be facilitated by various preservation techniques such as drying and product developments like essences, perfumes and oils. The floriculture industry is rapidly evolving with innovations in dry flower technology, nutraceutical extraction and eco-friendly processing techniques (Datta and Roy, 2023). Additionally, consumer acceptance research has confirmed that innovative processed floral products, such as those incorporating floral extracts into beverages and other food items, are well received in the market (Saati *et al.*, 2024). Expanding value addition in floriculture can reduce waste, create employment opportunities and open new markets for sustainable floral products. Diversifying the utility from the common fresh flower consumption pattern to varied product development and availability can lead to increased income and employment generation, reduced risk factor and enhanced market suitability.

Authors' contributions

SS collected and wrote the draft manuscript. RC reviewed and corrected the manuscript, while MG, AR, PM and PG provided valuable suggestions to enhance the manuscript's quality.

Competing Interests

Conflict of interest: Authors do not have any conflict of interests to declare.

References

Addor, F.A.S. (2017). Antioxidants in dermatology. *Anais Brasileiros de Dermatologia* **92**(3), 356-362. DOI: https://doi.org/10.1590/abd1806-4841.20175697.

APEDA (2017). India exports statistics. Apeda Agrixchange. Available at: http://agriexchange.apeda.gov.in. Accessed on: 1st June, 2024.

Bhati, M.I., Dubey, R.K., Singh, S. (2021). Review on Approaches to floral waste management for sustainable environment. *Climate Change and Environmental Sustainability,* **9**(2), 110-116. DOI: https://doi.org/ 10.5958/2320-642X.2021.00012.0.

Chang, S.M., Chen, C.H. (2016). Effects of an intervention with drinking chamomile tea on sleep quality and depression in sleep disturbed postnatal women: A randomized controlled trial. *Journal of Advanced Nursing,* **72**(2), 306-315. DOI: https://doi.org/10.1111/jan.12836.

Chauhan, A.S., Chen, C.W., Singhania, R.R., Tiwari, M., Sartale, R.G., Dong, C.D., Patel, A.K. (2022). Valorizations of marigold waste for high-value products and their industrial importance: A comprehensive review. *Resources* **11**(10), 91. DOI: https://doi.org/10.3390/resources11100091.

Chusak, C., Thilavech, T., Henry, C.J., Adisakwattana, S. (2018). Acute effect of Clitoriaternatea flower beverage on glycemic response and antioxidant capacity in healthy subjects: a randomized crossover trial. *BMC Complementary and Alternative Medicines,* **18**(1), 6. DOI: https://doi.org/10.1186/s12906-017-2075-7.

Das, S.C., Datta, S.K. (2022). Value addition: Dehydration of flowers and foliage and floral craft. In: *Floriculture and Ornamental Plants*. (Eds.) Datta, S.K. and Gupta, Y.C. *Handbooks of Crop Diversity: Conservation and Use of Plant Genetic Resources*. Springer, Singapore. pp. 219-261. DOI: https://doi.org/10.1007/978-981-15-3518-5_21.

Datta, S.K., Roy, S. (2023). Development of dry flower technology by CSIR-NBRI, Lucknow. *Science and Culture* **89**(5-6), 165-177. DOI: https://doi. org/1 0.36094/sc.v89.2023.Development_of_Dry_Flower_ Technology. Datta_Roy.165.

Dubey, N.K., Kumar, R., Tripathi, P. (2004). Global promotion of herbal medicine: India's opportunity. *Current Science* **86**(1), 37-41. URL: https://www.jstor.org/stable/ 24109515.

El-Naggar, H.M., Ali, S.M., Osman, A.R. (2024). A novel efficient multi-walled carbon nanotubes/gibberellic acid composite for enhancement vase life and quality of Rosa hybrida cv. 'Moonstone.' *BMC Plant Biology* **24**, 239. DOI: https://doi.org/10.1186/s12870-024-04925-9.

Feng, M., Zhang, M., Adhikari, B., Chang, L. (2024). Novel strategies for enhancing quality stability of edible flower during processing using efficient physical fields: A review. *Food Chemistry* **448**, 139077. DOI: https://doi. org/10.1016/j.foodchem.2024.139077.

Fernandes, L., Casal, S., Pereira, J.A., Saraiva, J.A., Ramalhosa, E. (2017). Edible flowers: A review of the nutritional, antioxidant, antimicrobial properties and effects on human health. *Journal of Food Composition and Analysis,* **60**, 38-50. DOI: https://doi.org/10.1016/j.jfca.2017.03.017.

He, J., Yin, T., Chen, Y., Cai, L., Tai, Z., Li, Z., Liu, C., Wang, Y., Ding, Z. (2015). Phenolic compounds and antioxidant activities of edible flowers of *Pyrus pashia*. *Journal of Functional Foods,* **17**, 371-379. DOI: https://doi.org/10. 1016/j.jff.2015.05.045.

Jain, R. (2016). Floral value-added products for employment generation. Available at: https://www.biotecharticles. com/Agriculture-Article/Floral-Value-AddedProducts-for-Employment-Generation3673.html. Accessed on: December 13, 2020.

Joyce, D.C. (1998). Dried and preserved ornamental plant material not new, but often overlooked and underrated. *Acta Horticulture,* **454**, 133-145. DOI: https://doi. org/10.17660/ActaHortic.1998.454.16.

Kobayashi, M., Kawashima, H., Takemori, K., Ito, H., Murai, A., Masuda, S., Yamada, K., Uemura, D., Horio, F. (2012). Ternatin, a cyclic peptide isolated from mushroom and its derivative suppress hyperglycemia and hepatic fatty acid synthesis in spontaneously diabetic KK-A(y) mice. *Biochemical Biophysical Research Communications* **427**(2), 299-304. DOI: https://doi.org/10.1016/j.bbrc. 2012. 09.045.

Koulivand, P.H., Ghadiri, M.K., Gorji, A. (2013). Lavender and the nervous system. *Evidence-Based Complementary and Alternative Medicine* 2013, 681304. DOI: https://doi.org/ 10.1155/2013/681304.

Li, Y., Lu, Y., Fu, J., Chen, B., Fu, L., Huang, X., Wei, Z., Zheng, Y., Zeng, Z., 2024. Multi-walled carbon nanotubes improve the development of Chrysanthemum × morifolium (Ramat.) Hemsl. 'Jinba' Inflorescences. *Horticulturae* **10**(4), 330. DOI: https://doi.org/10.3390/ horticulturae10040330.

Lillehei, A.S., Halcón, L.L., Savik, K., Reis, R. (2015). Effect of inhaled lavender and sleep hygiene on self-reported sleep issues: a randomized controlled trial. *The Journal of Alternate and Complementary Medicine* **21**(7), 430-438. DOI: https://doi.org/10.1089/acm.2014.0327.

Lourdusamy, D.K., Vadivel, E., Azhakiamanavalan, R.S. (2001). Research and development in dry flower technology. *Floriculture Today* **5**, 8-13.

Lu, B., Li, M., Yin, R., 2015. Phytochemical content, health benefits and toxicology of common edible flowers: A review (2000-2015). *Critical Reviews in Food Science and Nutrition* **56**(Sup 1), 130-148. DOI: https://doi.org/10. 1080/10408398.2015.1078276.

Mekala, P., Ganga, M., Jawaharlal, M. (2012). Artificial colouring of tuberose flowers for value addition. *South Indian Horticulture,* **60**, 216-223.

Muzamil, M., Ramzan, M.M., Huda, N., Alexandre, N., Irfan, M., Bashir, N., 2025. Utilization of fruits and flowers of *Capparis decidua* for the development of value-added jam. *Insights-Journal of Health and Rehabilitation,* **3**(1), 53-59. DOI: https://doi.org/10.71000/qtdgwv56.

Nagajyothi, G.N., Pratheeksha, C.T. (2023). Flowers: Potential source for nutraceutical industry. *International Research Journal of Modernization in Engineering Technology and Science* **5**(7), 3148-3162. DOI: https://doi.org/ 10.56726 /irjmets43601.

Nair, V., Bang, W.Y., Schreckinger, E. andarwulan, N., Cisneros-Zevallos, L., 2015. Protective role of Ternatin anthocyanins and Quercetin glycosides from Butterfly pea (*Clitoria ternatea* Leguminosae) Blue flower petals against Lipopolysaccharide (LPS)-induced inflammation in macrophage cells. *Journal of Agricultural and Food Chemistry* **63**(28), 6355-6365. DOI: https://doi.org/10.1021/acs.jafc.5b00928.

Nikjou, R., Kazemzadeh, R., Rostamnegad, M., Moshfegi, S., Karimollahi, M., Salehi, H. (2016). The effect of lavender aromatherapy on the pain severity of primary Dysmenorrhea: A triple-blind randomized clinical trial. *Annals of Medical and Health Sciences Research,* **6**(4), 211-215. DOI: https://doi.org/10.4103/amhsr. amhsr_ 527_14.

Oguis, G.K., Gilding, E.K., Jackson, M.A., Craik, D.J. (2019). Butterfly pea (*Clitoria ternatea*), a cyclotide-bearing plant with applications in agriculture and medicine. *Frontiers in Plant Science* **28**(10), 645. DOI: https://doi.org/10.3389 /fpls.2019.00645.

Pant, P., Singh, B. (2023). Refinement of technology on dry flowers: A review. *Agricultural Reviews* **44**(4), 516-522. DOI: https://doi.org/10.18805/ag.R-2267.

Różyło, R., Amarowicz, R., Janiak, M.A., Domin, M., Różyło, I., Rząd, K., Matwijczuk, A., Rusinek, R., Gancarz, M. (2024). Micronized rose petal powder: A valuable edible floral food ingredient containing bioactive compounds. *Molecules* **29**(20), 4931. DOI: https://doi.org/10.3390/ molecules29204931.

Saati, E.A., Purwati, T., Prayitno, T.A., Argarini, D.F., Mistianah, M., Ambarawati, M., Budiono, D., Herlambang, A. (2024). Consumer acceptance of processed telang Buteri flower and Buser King coffee products. *Edubiotik: Jurnal Pendidikan, Biologi Dan Terapan* **9**(02), 81-88. DOI: https://doi.org/10. 33503/ebio.v9i02.166.

Sharma, G. (2020). *Value Addition in Flowers*. National Webinar on Advances in Floriculture, UHS, Bagalkot and SAAHAS, September, **27**, 2020.

Shah, A.H., Singh, A., Laishram, N., Gill, K. (2022). Income generation through value addition of flower crops: A review. *International Journal of Environment and Climate*

Change, **12**(10), 593-613. DOI: https://doi.org/10.9734/ijecc/2022/v12i1030838.

Shukla, S., Gupta, S. (2010). Apigenin: a promising molecule for cancer prevention. *Pharmaceutical Research,* **27**(6), 962-978. DOI: https://doi.org/10.1007/s11095-010-0089-7.

Stoyanova, Y., Lazarova-Zdravkova, N., Peshev, D. (2025). Valorisation via nanofiltration of the antioxidant residual water from industrial hydrodistillation of *Rosa damascena* Mill. petals. *Journal of Chemical Technology and Metallurgy* **60**(1), 3-10. DOI: https://doi.org/10.59957/jctm. v60.i1.2025.1.

Susan, (1990). *Dried Flowers*. Merchants Ltd. Ferry House, London. p. 144.

Tarte, I., Singh, A., Dar, A.H., Sharma, A., Altaf, A., Sharma, P. (2023). Unfolding the potential of dragon fruit (*Hylocereus* spp.) for value addition: A review. *eFood* **4**(2), e76. DOI: https://doi.org/10.1002/efd2.76.

Weidner, C., Wowro, S.J., Rousseau, M., Freiwald, A., Kodelja, V., Abdel-Aziz, H., Kelber, O., Sauer, S. (2013). Antidiabetic effects of chamomile flowers extract in obese mice through transcriptional stimulation of nutrient sensors of the peroxisome proliferator-activated receptor (PPAR) family. *PLOS One* **8**(11), e80335. https://doi.org/10.1371/journal.pone.0080335.