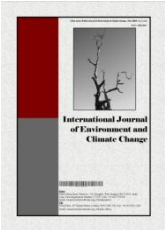

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Income Generation through Value Addition of Flower Crops: A Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Value added floriculture is a process of increasing the economic value and consumer appeal of any floral commodity through processing and packaging diversification. The value addition for marketing flowers includes adoption of postharvest technology and improved logistics. Value- addition ensures high premium to the grower, while providing more acceptable quality products for the domestic and export market, and it provides the most important aspects of marketing and give the customers a reason to buy such products. Value addition reduces post-harvest losses and diversifies the economic base of rural communities. The value-added products can be classified into three categories namely fresh flower products, dried flower products and processed flower products. The success of floral industry lies upon by strengthening the fresh flower market through value addition. Dry flower value added products of flowers through different methods have shown promising results. Tinting of cut carnation with food dye Pink and Orange Red @ 5% recorded the fastest uptake of 1 hour *Jasminum sambac* flowers harvested at the fully open stage yielded better quality essential oil compared with flowers harvested at the closed bud stage. Marigold is one of the richest source of carotenoids especially lutein which possess antioxidant activities and moreover intake of lutein helps in curing age related macular diseases. Natural dyes are mostly used in the colouring of textiles, drugs, cosmetics, etc. Chrysanthemum petals can be used as a substitute of synthetic reactive dyes for dyeing of cotton and silk fabrics (Das *et al*., 2016). Marigold flower provides a

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source of carotenoids commercially used in food colouring industries and poultry feed high in carotenoids has been shown to increase performance and egg yolk color as well as decrease egg cholesterol levels.

Keywords: Value addition; dried flowers; oil extraction.

1. INTRODUCTION

The term "value-added" describes the economic enhancement a company gives its products or services before offering them to customers. Value-added floriculture refers most generally to manufacturing process that increases the value of primary commodities. It is a process of increasing the economic value and consumer appeal of any floral commodity through changes in genetics, processing and packaging diversification with this profitability of a commodity is increased especially small scale floriculture industry. The value addition for marketing flowers includes adoption of postharvest technology and improved logistics.

The success of floral industry lies upon by strengthening the fresh flower market through value addition [1]. “Value-addition ensures high premium to the grower, while providing more acceptable quality products for the domestic and export market, and it provides the most important aspects of marketing and give the customers a reason to buy such products. Export of value-added product e.g. oil (extracted in small units set up in production zones) rather than the raw material e.g. rose petals, can help generate substantial revenue in international market. The Indian Floriculture market was worth INR 157 Billion in 2018. The market is further projected to reach INR 472 Billion by 2024, growing at a CAGR of 20.1% during 2019-2024” [2].

2. OBJECTIVES OF VALUE ADDITION

- To improve the profitability of farmers
- To empower the farmers and other weaker sections of society especially women throughgainful employment opportunities and revitalize rural communities
- To provide better quality, safe and branded products to the consumers
- To emphasize primary and secondary processing
- To reduce post harvest losses
- Reduction of import and meeting export demands. Way of increased foreign exchange
- Encourage growth of subsidiary industries
- Reduce the economic risk of marketing
- Increase opportunities for smaller farms and companies through the development of markets
- Diversify the economic base of rural communities
- Overall, increase farmers’ financial stability

2.1 Ways to add value

- Process the raw material
- Pre cut, wrap and package
- Take a unique approach
- Label the product
- Distinct product appearance
- Increase shelf life
- Gift baskets or multi-pack
- Build reputation, relationship

2.2 Parameters to Focus on for Value Addition for Maximum Benefits

Unique - The product developed should be one of its own kinds for which crop and variabilityindigenous to our country should be exploited.

Novelty - The product should be new and unusual like blue or black rose and likewise so that noone can compete.

Export potential - The product developed should have demand in international market for higher return and appreciation of benefit of global trade.

High value - The product should have high value for low volume for ease of trading and distribution.

Availability - Consistent availability of the product in required quantity should be ensured forstable market and faith.

Market - Any product that is developed must have market because market is the key for successof any product.

The value-added products can be classified into three categories namely fresh flowerproducts, dried flower products and processed flower products [3].

Fresh Flower Products: Cut flower arrangements like bouquets, baskets, bunch, buttonaire, corsage etc., Loose flower products like garland, floral strings, pomanders, wreaths, floral jewelry, garlands, veni, button-hole, flower baskets, floats, floral wreaths, corsages and edible flowers.

Dried Flower Products: Dried flower arrangements, products of press dried flowers, Pot pourries etc. Processed Flower Products: Essential oil, herbal medicine, dye yielding ornamentals, tinting of flowers, beverages, poultry feed, insect repellent, petal embedded handmade paper, cosmetics etc.

List 1:Area and Production of flowers for the last 10 years

Area in '000 Ha Production in '000 MT

Year	Area (ha)	Production (MT)
2010-11	191	1031
2011-12	254	1652
2012-13	233	1729
2013-14	255	2297
2014-15	249	2143
2015-16	278	2184
2016-17	306	2392
2017-18	324	2785
2018-19	303	2910
2019-20*	307	2994

**Advance Estimates*

List 2. Agri -Export Zone (AEZ) of India (Flower exporting zones)

S No	State	Districts / Area
1	Karnataka	Bangalore (Urban), Bangalore (Rural), Kolar, Tumkur, Kodagu and Belgaum
2	Uttarkand	Dehradun, Pantnagar, Udhamsingh Nagar, Nainital and Uttarkashi
3	Maharashtra	Nasik, Sangli, Sholapur, Satara, Ahmednagar
4	Tamil Nadu	Dharmapuri

Source: National Horticulture Board (NHB) Publication

2.3 Fresh Flower Products

Fig. 1. Cut flower arrangements and bouquets

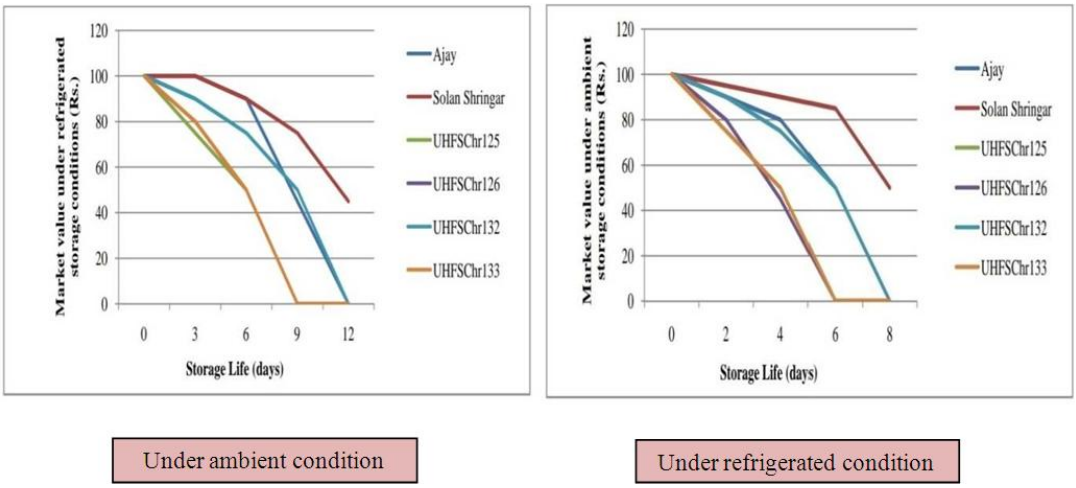

Fig. 2. Variation among different genotypes of chrysanthemum for market value (rs.) of ordinary bouquets under different conditions (chaudhary, 2020)

Fig. 3. Temple, church and stage decoration with fresh flowers

Fig. 4. Different types of flower arrangements in marriage hall of Bengaluru city alongwith their price range

Basanagouda [4] studied the cost and returns of flower decration for marriage hallsand for medium budget (Rs. 1-2 lakhs), and reported that cut flowers under variable cost was 2.63% and artificial and dry flowers under fixed cost was 6.02% and the net profit per marriage was 36%. The expenditure towards variable cost was more due to high cost of cut flowers.

Chaudhary [5] studied the market value for the sale of value-added products of chrysanthemum. For ordinary garlands, the market value was maximum in cv. 'Solan Shringar' and 'UHFSChr117' under ambient and refrigerated conditions. For special garlands, the market value was maximum in 'Ajay'+ 'UHFSChr134'+'Chrysanthemum Collection-1' under ambient and refrigerated conditions.

Fig. 5. Value added products of fresh loose flowers

Fig. 6. Ordinary and special garlands prepared from different genotypes of chrysanthemum

2.4 Edible Flowers

Flowers are associated with human life since time immemorial. Flowers can be added tofood to provide taste, aroma and colour. They can be used as part of your main dish, salads, desserts, spreads, fruit jamsa nd vinegars. Beside aesthetic beauty, several flowers are used for edible purpose viz., rose, marigold, calendula, hibiscus, hollyhock, carnation, chrysanthemum, nasturtium, lotus, cosmos and pansies etc. These flowers have medicina as well as nutritional values and are rich source of vitamins, antioxidants and mineral elements. The flowers are enriched with various pigments viz., chlorophyll, flavonoids, xanthophylls, carotenoids, betalains and anthocyanin that are generally used in coloring food, beverage, and textile and paper industries. Edible flowers have anticancer, anti-inflammatory, antitumor, antimicrobial and antimutagenic properties too. The flowers are used as vegetables and other purpose since time immemorial, however, flowers for supplementary health products is comparatively a new concept and therefore needs further research to utilize flowers as nutraceuticals.

Rop *et al. [6]* investigated "12 species of edible flowers and found that the total contents of phenolic substances ranged from 2.53 to 5.11 g of gallic acid/kg of fresh mass (FM) which were comparable with those found in common kinds of fruit, e.g., plums (3.48– 4.95 g of gallic acid/kg of fresh mass), blueberries (3.00–4.89 g of gallic acid/kg of fresh mass), black currants (in average 5.33 g of gallic acid/kg of fresh mass), etc. further reported that the highest levels of mineral elements were observed in the flowers of species chrysanthemum, dianthus or viola and the most abundant element was potassium, the content of which ranged from 1,842.61 to 3,964.84 mg/kg of fm".

2.5 Beverages

As flowers are a promising source of minerals, antioxidants, vitamins and dietary fibres different beverages, cocktails, teas, dressings, gulkhan, rose sharbat and champagne are made from flowers and floral parts.

Table 1. List of some edible flowers

Botanical name	Common name	Taste	Colour
Antirrhinum majus	Snapdragon	Bitter	Wide range
Bellis perennis	Daisy	Mildly bitter	White
Calendula officinalis	Marigold	Slightly bitter	Yellow, orange
Centaurea cyanus	Cornflower	Vegetal	White, pink, blue
Dianthus caryophyllus	Carnation	Sweet clove	Wide range
Helianthus annuus	Sunflower	Varies	Yellow
Hemerocallis	Daylily	Vegetal, sweet	Wide range
Hibiscus rosa-sinensis	Chinese hibiscus	Cranberry-like	Rose, red
Lavandula	Lavender, etc.	Sweet, perfumed	Lavender
Lonicera japonica	Japanese honeysuckle	Sweet	hite to pale yellow
Matricaria recutita	Camomile	Sweet apple	White
Pelargonium	Geranium	Varies	Wide range
Phalaenopsis	Moth Orchid	Watery	Varies
Botanical name	Common name	Taste	Colour
Rosa	Rose	Perfumed	Wide range
Salvia elegans	Pineapple sage	Sweet, fruity	Red
Salvia officinalis	Common sage	Herbal	Purple-blue
Tagetes patula	French marigold	Bitter	Yellow, orange
Tagetes tenuifolia	French marigold	Spicy, herbal	Yellow
Taraxacum officinale	Common dandelion	et, honey- like	Yellow
Trifolium pratense	Red clover	Sweet	Red
Tropaeolum majus	Nasturtium	Spicy, peppery	Wide range
Tulipa	Tulip	Vegetal	Wide range
Viola odorata	Common violet	Sweet, perfumed	Purple, white
Viola tricolor	Heart's ease, etc.	Wintergreen	urple and yellow

Table 2. Total phenolic content (TPC) (g oggallic acid/kg of FM), total antioxidant capacity (TAC) (g of ascorbic acid equivalent/kg of FM and total flavonoid content (TFC) (g of rutiin/kg of FM) in species of edible flowers, n=10

Species	TPC	TAC	TFC
Antirrhinum majus	3.49±0.21 [a]	5.06±0.24[a]	1.78±0.18[a]
Begonia boliviensis	4.92±0.16 [b]	6.80±0.29[b]	1.84±0.20[a]
Centaurea cyanus	4.76±0.27 [b]	6.81±0.26[b]	1.81±0.21 [a]
Chrysanthemum frutescens	2.53±0.25 [c]	4.24±0.30[c]	1.23±0.17[b]
Chrysanthemum parthenium	2.72±0.27 [c]	4.21±0.31 [c]	1.29±0.20[b]
Dianthus caryophyllus	5.28±0.41 [b]	6.96±0.39 [b]	2.27±0.020[c]
Fuchsia x hybrida	3.45±0.30 [a]	5.20±0.21 [a]	1.66±0.21[ab]
Impatiens walleriana	4.85±0.28 [b]	6.89±0.36 [b]	1.93±0.18[ab]
Rosa odorata	5.02±0.34 [b]	6.85±0.38 [b]	2.04±0.19[ac]
Tagetes patula	4.58±0.40 [b]	6.70±0.37 [b]	1.90±0.22[ac]
Tropaeolum majus	3.31±0.29 [a]	5.12±0.20 [a]	1.35±0.17[b]
Viola x wittrockiana	5.11±0.37 [b]	6.65±0.37 [b]	1.99±0.23 [ac]

Different superscripts in each column indicate the significant differences in the mean at p<0.05

Fig. 7. Edible flowers incorporated in food

2.6 Dried Flower Products

Dry flowers don't mean only flower parts, but also includes dried shoots, seeds, barks etc. In this industry, cut flower, foliage, ferns, grasses, sedges, seed pods, flower skeletons; nuts , fruits and cones; barks, branches, lichens and fungus are utilized. They are widely used to make handmade paper, lampshades, candle, bags, photo frames, boxes, books, wall quilts, cards and several gifts. The use of dry flowers in the making of these products enhances the appearance and beauty of these products. Among the floriculture products, dry flower leads in export from India followed by cut flowers, live plants, bulbs, tubers etc.

The UK is the largest importer of dry flowers accounting for 65 million US$ import, amounting to 40.7% of the total, followed by France and

Japan [7]. Major import destinations of dry flowers from India are USA, The Netherlands, UK, Germany and United Arab [8]. Dry flowers are essential export items both in national and international markets. Indian export of flowers is composed of 71% dry flowers exported mainly to USA, Japan, Australia, Russia and Europe [9]. Export of dried flowers and plants from India is about Rs 100 crore per year. The industry exports 500 varieties of flowers to 20 countries. It is also one of the major exporters of dry flowers, comprising 7% of the global trade.

"The dried ornamental products offer a wide range of qualities like novelty, longevity, aesthetic properties, flexibility and year round availability" [10]. "Processing of dry flower involves mainly three steps namely drying, bleaching and colouring" [11]. "Dry flowers and their products look fresh and appealing for years together" [3].

2.7 Methods of Drying

Air Drying: Flowers are dried by tying them into small bundles and hanging them upside down in a warm and ventilated place away from direct sunlight, that is, in a cool dark area.The drying process may take from one week to several weeks depending on the size of flower, type of flower and the temperature and humidity of the drying space. Dried flowers are brittle and the stems are straight since they were hung upside down, giving it an unnatural look. Flowers that can be dried using this method are hydrangeas, celosia, globe amaranth, strawflowers, acroclinum, gypsophilla, helichrysum, larkspur, limonium, statice etc. In this method, flowers with blue and yellow colour petals retain their colour under air drying but, pink colour flowers are faded [12].

Press drying: "Commonly used by the herbalists or botanists for the preparation of herbarium. The flowers and foliage are placed between the folds of newspaper sheets or blotting papers giving some space among flowers. These sheets are kept one above the other and corrugated boards of the same size are placed in between the folded sheets so as to allow the water vapour to escape" [13]. "The drying time can be reduced if the sheets are kept in oven at an appropriate temperature" [14]. "The best examples of plants for this method are leaves of adiantum, silver oak, thuja, etc. and flowers of aster, bougainvillea, candytuft, chrysanthemum, euphorbia, hibiscus, ixora, lantana, marigold, melia, rose, verbena etc. flowers and foliage became flat after drying; hence it is suitable for the preparation of different handicrafts like greeting cards and other floral arrangements to decorate the wall" [13].

Embedded drying: "Sand, borax, silica gel, sawdust, perlite and combination of these are used as media for embedding. Among these, sand and borax are cheaper but they take more time for drying. Silica gel is spread in a wide flat pan up to a height / thickness of ½ to ¾ of an inch. The flowers are arranged in the gel and more silica gel is poured on top, till the flowers are completely covered. These are to be placed in airtight conditions, as otherwise silica gel will absorb moisture from the air and will become moist thereby slowing the process of drying the flowers or not drying at all. The flowers take from a few days up to a week to dry depending onthe size and number of flowers and the moisture content in the flowers. Flowers that can bedried using this method are, roses, tulips, anemones, zinnia, allium, etc. For delicate flowers like roses, dahlia, carnation etc, silica gel is the ideal drying agent" [15].

Glycerine drying: The technique is applied for the preservation of flowers and foliages rather than drying. Water and glycerin are taken in the ratio 2:1 and mixed. Fresh cut flowers are left in the water-glycerin solution where the water in the flowers is replaced by the glycerin, thereby making the flower supple and long lasting. Suitable plants for this technique are eucalyptus, gypsophilla, hydrangea, magnolia, maple leaves etc. Malakar *et al.* [16] reported that glycerin uptake increased with the increase of extended absorption duration. Utmost moisture loss percentage was obtained in *Thuja orientalis* under hot-air-oven drying after 96 hours absorption in 1:1 glycerin water solution. Yadav [17] studied the different methods of uptake and concentrations of glycerine of different foliage viz., *Peltophorum pterocarpum, Buxus sempervirens, Grevillea robusta, Polystichum squarrosum, Thuja compacta* and *Cupressus torulosa* and found that the overall acceptance was highest *at* 40% glycerine under full dip method for all the foliage and among the foliage *Grevillea robusta* gave the best result.

Table 2. Effect of condition of storage (C), duration (D) and their interaction on keeping quality of dried *Gomphrena globosa* 'White' (Score out of 10). (Kumari, 2015)

	C_1			TxC	C_2			TxC	C_3			TxC	TxD			T
	D_1	D_2	D_3		D_1	D_2	D_3		D_1	D_2	D_3		D_1	D_2	D_3	
T_1	8.87	5.90	2.90	5.89	8.90	7.03	5.43	7.08	9.40	8.40	7.40	8.39	9.06	7.11	5.23	7.12
T_2	7.97	6.40	4.10	6.05	8.10	5.10	4.00	5.61	8.40	7.97	6.10	7.39	8.01	6.50	4.73	6.35
CxD	8.42	6.15	3.50	5.97	8.50	6.07	4.70	6.35	8.68	8.20	6.75	7.89	8.53	6.81	4.98	

CDYYY
T=0.04
C=0.05
D=0.06TxC=0.07
TxD=0.09
CxD=0.11
TxCxD=0.15

TY= Silica gel+ 4 mins. + 24 hours (microwave oven dried flowers)
TY= Silica gel +50°C + 24 hours (hot air oven dried flowers)

CY= Open (without any cover)
CY=Covered (Cellophane sheet)CY= Covered Newspaper

DY= 0 days
DY= 60 days
DY= 120 days

Freeze drying: In this method, fresh flowers are dried by a process called sublimation wheretheir natural shape and colour are preserved. Flowers are frozen below freezing point for at least12 hours. After the freezing process, the moisture in the flowers is pulled out using a vacuum pump in the form of vapour in a chamber and this vapour condenses as ice in another chamber. The natural colours of the flowers are preserved despite the freeze drying process. Freeze dried products are mainly used to decorate cake, wedding bouquets or decorating the table by scattering of dried products etc. Suitable plants for this technique are alstroemeria, amaranthus, aster, bird of paradise, calla lily, carnation, daffodil, dahlia, delphinium, freesia, gardenia, gladiolus, gypsophilia, hyacinth, hydrangea, iris, lily, narcissus, orchid, peony, phaleonopsis,rose, snap dragon etc. The main disadvantages of this technique are the time-consuming process required about a month and high cost investment for sophisticated instruments. Behara [18] studied the effect of drying duration on moisture loss and anthocyanin content of flowers of rose cv. 'first red' dried in lyophilizer where the fresh flower anthocyanin content was 1.57 mg/g (Table 3).

2.8 Skeletonizing

Also called fossil leave, as it is a semi-transparent. It is a process by which all tissues from leave are eliminated without hampering of veins. Leaves are boiled in 250 ml of water with the addition of 2 tablespoon lye for 40 minutes. Sometimes, 2 tablespoon household bench is added in water for 2 hours. After that, leaves should be rinsed in cold water and remove the tissue from leaves with paintbrush or toothbrush followed by drying. Utilized as gift tags, greeting cards, scrapbooks, collages, paper making, stamping or decorating wedding cards.

Dry flower arrangement

Wall hanging

Dry flower products

Dry flower basket

Rakhi

Potpourri

Pine cone show piece

Dolls made of maize sheath

Flowers made of maize sheath

Pressed flower Coaster

Pressed flower cards

Flower embedded ornaments

Pressed flower bookmark

Dried flower phone case

Pressed flower frames

Fig. 8. Value added dried flower products

Table 3. Effect of drying duration on moisture loss (%) and anthocyanin content offlowers of rose cv. 'First Red' dried in lyophilizer

Duration	Moisture loss (%)	Anthocyanin content (mg/g)
Dϒ= 24 hours	77.26	1.27
Dϒ= 36 hours	80.50	1.22
Dϒ= 48 hours	87.29	0.79
Mean	81.68	1.09
CDϒϒϒ	0.14	0.02

Fig. 9. Skeletonized leaves

2.9 Bleaching and Dyeing

Blenching is a process where chemicals are used for discolourizing or whitening. Dehydrated products are mainly less colour intensive and reduce the visual appearance. Therefore, flowers are introduced with blenching followed by dyeing for better absorption of dye. Flowers can coloured by both natural dye and synthetic chemicals like enamel paints, interior paints, poster paints, tube paints etc. Blenching with Sodium chlorite (10%) followed by Hydrogen peroxide (30%) shown effective result on gomphrena [12]. Jawaharlal *et al*. [19] reported that "dried pods of *Jacaranda mimosifolia* and *Castanospermum australe* were fully bleached by soaking overnight in 10% sodium hydroxide and subsequent treatment with 2% sodium hydroxide + 2.5% sodium silicate + 35% hydrogen peroxide (Table 4). Bleached pods were given dye treatments viz., acid dye, basic dye, food dye and acrylic dye where acrylic dyes took the least time for dye uptake for both *Jacaranda mimosifolia* and *Castnospermum austral* ie, 1.4 and 1.6 minutes, respectively and showed good dyeing consistency, light fastness, wash fastness and rubbing fastness". Sharma [20] also reported that higher concentration of organic dye with alum as mordant gave the best result for dried flowersof *Ornithogalum thysoides.*

2.10 Tinting

Tinting is an important value addition technique in flower crops where colour pigments are absent or in light colour flowers. Tinting can be done with natural flowers by adding artificial colours or food colouring agents. The coloured inflorescences of the cut flowers with edible dyes enhance the appearance and appeal the arrangement to be more attractive. The tinting helps to add colour or combination of two colours in cut flowers to enhance the aesthetic value and novelity of the cut flower arrangement. Sowmeya *et al.* [21] studied the effect of different tinting treatments of food dye solutions viz., Apple Green, Lemon Yellow, Blue, Pink and Orange Red each at 5% concentrations on colour intensity and colour uptake in cut rose and carnation and found that Orange + Yellow and Orange + Pink resulted best recording 2 hours and 1hours, respectively for colour uptake. Safeena *et al*. [22] reported that longer time of immersion (24 hours) allowed more dye to be translocated throughout the flower spike of tuberose cv. 'mexican single' (Table 5).

2.11 Essential Oils

Flower and fragrance plant industry is an upcoming sector with tremendous opportunities for India to have its due share in the international trade in es ential oils. Worldwide demand for flavours and fragrances including blends, essential oils and other natural extracts is projected to increase 4.3 % per year. India ranks 26th in import and 14th in respect of export in world in the trade of essential oil. india holds around 0.7% of import & 1.1% of export. jasmineand tuberose concentrate from south india have created a marks in world marked. the major buyers of indian essential oil are former ussr, usa, france, uk, netherlands, uae and saudi arabia. the market value of essential oils worldwide is expected to grow from around 17 billion u.s. dollars in 2017 to about 27 billion dollars by 2022. europe accounts for the largest share of the global essential oils market, with the asia pacific region and north america tying for second place. in india, there are more than 450 plants that can yield dyes. the india essential oils market is expected to reach an output of ~50,400 tons by the end of 2030 (source: www.transparencymarketresearch.com). growth in perfumery is higher i.e.,15% in india compared to 7% in america and 5% in europe .the world production of essential oils is growingat more than 10% annually and at present it is estimated at about 11000 tonnes valued at over 11 billion us dollars. india contributes 16% to the world production, next only to brazil and usa. india is the second largest exporter of jasmine oil in the world accounting for over 40% of total world exports in jasmine oil. europe continues to be the largest destination of india's floriculture exports [23]. younis *et al*. [24] investigated the relative percentages of the main constituents identified through gas chromatography in the essential oil of *jasminum sambac* flowers harvested at different stages and reported that flowers harvested at fully open flower stage contains higher percentage of essential oil constituents (Table 6).

2.12 Pharmaceutical Properties

"Flower crops are considered as rich source of various nutraceutical and pharmaceutical compounds that are being commercially exploited worldwide. These bioactive compounds play a significant role in plant as well as human health. Polyphenols, flavonols, pigments etc. are the important bioactive compounds that are found in most of the plant

species. Plants synthesize secondary metabolites which include alkaloids, flavonoids, saponins, terpenoids, steroids, glycosides, tannins, volatile oils etc., The therapeutic efficacy of plants is because of these secondary metabolites for curing many diseases. Phytochemicals are pharmacologically active compounds. These include alkaloids have an antispasmodic, antimalarial, analgesic, diuretic activities; Terpenoids are known for their antiviral, anthelmintic, antibacterial, anticancer, antimalarial, anti-inflammatory properties; Glycosides are reported for antifungal and antibacterial properties; Phenols and flavonoids have an antioxidant, antiallergic, antibacterial properties etc. and Saponins are reported to have anti- inflammatory, antiviral, plant defence activities" [25,26].

2.12 Dye Yielding Ornamentals

"Natural dyes are mostly used in the colouring of textiles, drugs, cosmetics, etc. Owing to their non-toxic effects, they are also used for colouring various food products. Flower pigments are anthocyanins — red, purple, and blue colors; water soluble, flavones — pale yellow colors; water soluble, carotenes — yellow, orange, and red colors: oil or at soluble. Natural dyes have better biodegradability and higher compatibility with the environment. Theyare non-toxic, non-allergic to skin, non-carcinogenic, easily available and renewable [27,28].

Samyal [29] studied fifteen dye sources and found that rose, marigold and turmeric were best source of bio-colour w.r.t. overall acceptability scores and that bio-colour can be successfully extracted from turmeric, rose and marigold; with acetone as a solvent, alum as a mordant and sodium chloride or acetic acid as dye assistants in case of turmeric and marigold whereas; sodium chloride or hydrochloric acid were found to be suitable dye assistants for rose (Fig.11).

Table 4. Effect of bleaching agent on time taken for complete bleaching in Jacaranda mimosifolia and Castnospermum australe

Treatment	Jacarand apods (hrs)	stanospermum pods (hrs)	Effect observed
2% NaOH + 2.5% NaϒSiOϒ + 30 %HϒOϒ	24	24	Fully bleached
2% NaOH + 2.5% NaϒSiOϒ + 35%HϒOϒ	18	12	Fully bleached
2% NaOH + 2.5% Na□SiOϒ + 40 %HϒOϒ	18	18	Fully bleached
30% NaOCl + 10% HCl	24	24	Unbleached
35% NaOCl + 11.5% HCl	24	24	Unbleached
40% NaOCl +13% HCl	24	24	Unbleached
30% NaClOϒ +10% HCl	24	24	Partially bleache d
35% NaClOϒ +11.5% HCl	24	24	Partially bleache d
40% NaClOϒ +13% HCl	24	24	Partially bleache d

Fig. 10. Tinting of cut carnation and rose

Table 5. Effect of different time of immersion on overall acceptability of flower spikes of tuberose cv. Mexican single (score out of 5)

Treatments	Tartrazine (Lemon yellow)	Sunset yellow + Carmosine (Orange red)	Tartrazine +Brilliant blue (Apple green)	Tartrazine +Carmosine + Sunset yellow (Orange)	Roya lblue	Brillian tblue
TϒT (4hours)	2.417	3.750	3.292	2.667	1 067	2.083
TϒT (15hours)	3.083	4.083	3.817	3.167	1 500	2.667
TϒT (24hours)	4.033	4.667	4.250	3.542	1 750	3.042
SEm	0.367	0.097	0.173	0.104	0 093	0.151
C.D (P=0.05)	1.101	0.293	0.520	0.313	0 280	0.452

Table 6. Relative percentages of the main constituents identified through gas chromatography in the essential oil of *Jasminum sambac* flowers harvested at different stages.

Sr. no.	Constituents	Closed bud stage (%)	Fully open flower stage (%)
1	Benzyl alcohol	4.51	5.26
2	Benzyldehyde	1.34	3.29
3	Citral (mixture of cisand trans)	0.58	0.73
4	Linalool	1.45	2.31
5	2-Phenyl ethyl acetate	2.73	3.01
6	Geraniol	3.89	6.26
7	Eugenol	5.98	9.8
8	Farnesol	8.91	8.31
9	Citrinyl acetate	3.56	3.57
10	Nerol	-	0.39
11	Geranyl acetate	2.79	4.98
12	Nerayl acetate	-	1.00
13	Citronellol	17.98	19.37
14	Phenyl ethyl alcohol	12.98	14.11

Table 7. List of essential oil yielding flowers

Botanical name	Common name	Family	Properties
Chrysanthemum spp.	Chrysanthemum	Asteraceae	Antibacterial activity
Polianthes tuberosa	Tuberose	Asparagaceae	Aphrodisiac, relaxant, sedative, anti-spasmodic, anti-nausea and antidepressant
Jasminum grandiflorum	Chameli	Oleaceae	Antidepressant, antiseptic, aphrodisiac, antispasmodic, sedative
Jasminum sambac	Arabian jasmine	Oleaceae	Antibacterial Antidepressant, antiseptic, aphrodisiac
Rosa damascene	Rose	Rosaceae	Antiviral, antibacterial, antidepressant, antioxidant, analgesic, anti-inflammatory, anticonvulsant activities.
Pelargonium graveolens	Geranium	Geraniaceae	Antibacterial, antioxidant, anti-fungal, analgesic and anti-anxiety properties
Helichrysum italicum, H. gymnocephalum	Helichrysum	Asteraceae	Anti-inflammatory, antifungal,antibacterial, antiseptic
Gardenia jasminoides	Cape jasmine	Rubiaceae	Anti-inflammatory
Lonicera japonica	Honeysuckle	Caprifoliaceae	Antibacterial activity
Hibiscus rosa-sinensis	China rose	Malvaceae	Anti-oxidants
Lavendula officinalis L. angustifolia	Lavender	Lamiaceae	Promote sleep and relaxationand relieve anxiety.
Crocus sativus Linn.	Saffron	Iridaceae	Antifungal, inflammationvandantioxidant

Fig. 11. Incense sticks incubated at department of floriculture and landscape architecture, dr ys parmar university of horticulture and forestry, nauni by mr ravinder prasher of una distt(yuvan vendors india pvt ltd)

Table 8. List of some pharmaceutical plants

Botanical name	Part use	Uses and properties
Calendula spp	Flower	Anti-inflammatory, antibacterial, antitumor. Skin and cancer treatments.
Echinacea purpurea	Whole plant	Cold, flu, minor infections, immunostimulant
Jasminum officinale	Flower	Ear ache & Puss formation, Stomatitis, Anticancer, Antibacterial, Antifungal
Jasminum sambac	Flower	Stomatitis, Wound, Antistress, Anti-diabetic, Anti oxidant, Anti-inflammatory, Anti-viral, Cardiac, Anti-acne, Analgesic,
Tagetes minuta	Flowers	Colds, respiratory inflammations, antispasmodic, antiparasitic, antiseptic, sedative, skin infections.
Rosa centifolia	Rose hip, flowers	Stomatitis, antioxidant Antibacterial
Hibiscus rosa-sinensis	Flowers	activities, Antitumor,Antihypertensive, Antioxidant, Antiammonemic, Hypoglycemic activity
Clitoria ternatea	Whole plant	Antimicrobial, antipyretic, anti-inflammatory, analgesic, diuretic, local anesthetic, antidiabetic, insecticidal, antidepressant, anticonvulsant, tranquilizing and sedative agent.
Nelumbo nucifera	Flowers, leaf, seed	Urine with burns, Diarrhoea with fever, Anti-bacterial, Anticancer, Antifertility Anti-inflammatory, Eye diseases, Bronchitis, Bleeding from nose
Nyctanthes arbortristis	Leaf, stem, bark	Antimalarial, Antiallergic, Antibacterial, Antiviral,Antioxidant, Antiinflammatory, Antipyretic, Immunopotentiator
Ginkgo biloba	Leaf	Age-related memory asthma, bronchitis, fatigue, Alzheimer's and tinnitus
Terminalia chebula	Fruit	Antioxidant

Botanical name	Part use	Uses and properties
Bauhinia purpurea	Roots an dleaves	Catarrh, boil, glandular swelling
Cynodon dactylon	Whole plant	Antidiabetic, Diuretic, Antioxidant, Antiviral, Immunomodulatory, Antiulcer, Antiarrhythmic,Wound Healing
Thuja occidentalis	Leaves	Respiratory tract infections, bacterial skin infections, cold sores, osteoarthritis, expectorant, immunostimulant, diuretic.

Das *et al*. [30] conducted "to extract dye from natural and herbal sources of flower petals from two different color dark purple and red variety of chrysanthemum (*Dendranthema grandiflora*). Both type of fabrics (cotton, silk) used for dyeing were boiled in NaOH solution (10 %) for 15 min to remove starch from the cloth, and then washed with cold distilled water. For mordanting, copper sulphate ($CuSO_4$, $5H_2O$) with concentration of 20-30 g/l was used and the fabrics were then transferred in mordant for 30 min followed by treatment in the dye bath for one hour. The result showed that chrysanthemum petals can be used as a substitute of synthetic reactive dyes for dyeing of cotton and silk fabrics and that the dyes have strong color properties even after washing with detergents, but also have major advantage of being eco-friendly and can help to minimize the problems of effluents from synthetic dyes" (Fig. 12).

Insecticidal properties

- ***Nerium oleander:*** Leaf extract-Larvicidal against the larvae and pupae of *Anopheles stephensi*
- ***Chrysanthemum cinerariaefolium****:* Pyrethrum/Pyrethrins as Insecticidal for crawling and flying insects such as cockroaches, ants, mosquitoes, termites.
- ***Azadirachta indica****:* Azadirachtin/Neem oil, Neem cake, Neem powder Bionimbecidine Repellent Antifeedant Nematocide sterilant, nematodes, sucking andchewing insects (caterpillars, aphids, thrips, weevils)
- ***Lantana camara***, ***Tagetes minuta*** and ***Azadirachta indica*** against malaria vector, *Anopheles gambia*

Fig. 12. Dyeing of fabrics chrysanthemum flowers extract

Table 9. List of dye yielding ornamentals

Botanical name	Common name	Family	Part used	Dye colour
Althea rosea	Holly hock	Malvaceae	Flower	Red
Tagetes erecta; T. petula	Marigold	Asteraceae	Flower	Yellow, brown
Bougainvillea glabra	*Bougainvillea*	Nyctaginaceae	Flowers and bracts	Yellow, brown
Butea monosperma	Flame of the forest	Papilonaceae	Flower	Yellow, orange
Gardenia jasminoides	Cape jasmine	Rubiaceae	Fruit	Yellow
Carthamus tinctorius	Safflower	Asteraceae	Flower	Red
Nymphea alba	Water Lily	Nympheaceae	Rhizome	Blue
Michelia champaka	Champak	Magnoliaceae	Flower	Yellow
Nyctanthes arbortristis	Coral jasmine	Oleaceae	Flower	Yellow
Peltophorum pterocarpum	Copper pod Wood	Caesalpiniaceae	Leaf	Brown, black
Lawsonia inermis	Henna	Lythraceae	Leaf	Orange, red
Bixa orellena	*Bixa*	Bixaceae	Pulp (aril)	Orange, red
Bauhinia variegata	Mahua tree)	Caesalpinaceae	Bark	Yellow
Indigofera tinctoria	Indian indigo	Fabaceae	Leaf	Blue, blue-black
Tecoma grandis	*Tecoma*	Verbenaceae	Leaf	Yellow
Terminalia arjuna	Arjun tree	Combretaceae	Bark	Light brown
Terminalia chebula		Combretaceae	Fruits	Yellow
Woodfordia fruiticosa		Lythraceae	Leaves, flowers	Pink, red

Table 10. List of ornamental plants and order of insects controlled

Family	Scientific name	Common name	Order of insects controlled
	Achillea millefolium L.	Yarrow	Lepidoptera, Coleoptera
	Calendula officinalis L.	Calendula	Hemiptera
	Centaurea cyanus L.	Garden cornflower	Hemiptera
	Centaurea jacea L.	Brownray knapweed	Hemiptera
	Echinacea purpurea L.	Purple coneflower	Lepidoptera
Asteraceae	*Eupatorium hyssopifolium*	Hyssopleaf thoroughwort	Hemiptera, Diptera
	Helianthus annus L.	Sunflower	Isoptera, Coleoptera
	Helichrysum bracteatum	Strawflower	Isoptera, Coleoptera
	Tagetes erecta	African marigold	Coleoptera
	Tagetes patula	French marigold	Diptera
	Tanacetum vulgare L	Common tansy	Lepidoptera
Myrtaceae	*Callistemom citrinus* (Curtis)	Crimson/common red bottlebrush	Coleoptera
ulacea e	*Primula veris* L.	Cowslip	Coleoptera

Amoabeng et al., [31]

Poultry Feed: Marigold flower provides a source of carotenoids and poultry feed high in carotenoids has been shown to increase performance and egg yolk color as well as decrease egg cholesterol levels [32]

Image 1. Egg yolk color

- **Nasturtium:** Leaves and the flowers are natural wormer and also have antibiotic properties.
- **Roses and rose hips:** Cleanse blood toxins and act as antiseptics and antibacterial agents.
- **Clover blossom:** Both a blood purifier and an antioxidant, clover provides calcium, iron,magnesium and Vitamins A, B-12 and E as well as respiratory benefits.
- **Echinacea flowers and seeds:** Improves respiratory health. [33]

Fish Feed: The pigmentation degree in skin of goldfish increased significantly with increasing inclusion of marigold meal at 200 mg of carotenoid/kg diet [34].

Cosmetics and beauty products: Flowers and flower parts are valued for their gentle yet potent healing properties that address a host of skin cocerns and beauty needs [35]. Floral extracts contain vitamins and antioxidants that help moisturize, cleanse and smoothen skin, as well as fight early signs of aging and free radical damage. Different cosmetics and beauty products like lotions, perfumes, soaps, rose water, face mask, cream, shampoo, etc are made from different flower extracts which adds to the value of the flowers [36].

Fig. 13. Color differences of goldfish fed experimental diects.$^{1}T_O$=Control diet, T_1=Diet with marigold meal (100mg of carotenoid supplementation kg^{-1} of fed), T_2= Diet with marigold meal (150mg of carotenoid supplementation kg^{-1} of feed), T_3= Diet with marigold meal (200mg of carotenoid supplementation kg $^{-1}$ of feed)

4. CONCLUSION

As flower crops are perishable in nature, it needs value addition to enhance the value and for marketing. More flowers and plant parts can be exploited for value added products. Different value added products are formulated and marketed which fetch high prices. Value addition creates employment for youth and women, it is a business strategy for creating new market demands or indulging renewed demand from the set of conventional customers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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