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Abstract

Floriculture is presently considered as the most lucrative agro-enterprise in terms of profit making. As the flowers are the utmost perishable horticultural farm produce, there remains some hindrance in proper marketing following standard postharvest management practices by the common farmers. Hence, value addition by the agro-industries is another important arena for proper utilisation of fresh ornamentals in either garden-fresh or processed form. Different kinds of value-added products are nowadays formulated and marketed by the companies which include essential oils, flavours, fragrance, pharmaceutical and nutraceutical compounds, insecticidal and nematicidal compounds, pigments and natural dye, vanilla-based products, gulkand, rose water, etc. Besides floristry items, flower arrangements and floral ornaments are important value addition with the fresh flowers and other ornamentals. Another important arena is the production of dry/dehydrated flowers in which India has achieved a considerable success regarding in-house production and worldwide marketing. The different methods for the production of value-added products from flowers and other ornamentals are discussed in this chapter.

5.1 Introduction

One of the most rapidly growing sectors of this era is the floriculture industry that has significantly increased the economy of the country

through the profits gained by marketing and export of not only the cut flowers and ornamentals but also the value-added products that can also be derived from these plants. Value-added floriculture is a process of increasing the economic value and appeal of any floricultural commodity through changes in genetics, processing or diversification (Verma et al. 2012). By application of such innovative techniques, the grower is able to receive an additional income by converting an indistinctive raw material into a unique

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and alluring product. However, before the producer can make such an enterprise a successful one, he/she has to be able to exert a substantial amount of time, labour and skill, more than that which is usually required for other farming operations.

5.2 Types of Value-Added Products

Value addition has become a magnanimous incentive towards the expansion of floricultural trade by the art of preservation of ornamental plants and the creation of novel products that appeal to the tastes and preferences of the customers. The procreative skills such as flower arrangements, artificial colouring of flowers, aqua packing for better presentation, three-dimensional window packing of flowers for greater visibility, garlands, venis, bouquets, greeting cards using petal-embedded craft papers, dry flowers, potpourris, etc. are some of the value-added products that have gained an escalating acceptance in the global market. Other value-added products obtained from flower crops are essential oils, flavours, fragrance, pharmaceutical and nutraceutical compounds, insecticidal and nematocidal compounds, pigments and natural dye, gulkand, rose water, vanilla products, etc.

5.2.1 Floral Ornaments

The innovative nature of mankind with the innate desire for beautification and decoration has led to the use of flowers and flowering parts for indoor decoration, hair decoration, making garlands, bouquets and for worship.

5.2.1.1 Garlands

Floral garlands are possibly one of the most ancient methods of using flowers for decoration with special preference for sweet-scented flowers. The highly demanded flowers for this purpose are jasmine and tuberose and other flowers include marigold, chrysanthemum, crape jasmine (*Tabernaemontana divaricata*) and rose. Red

hibiscus is particularly used for making garlands that are offered to the Goddess Kali who is worshipped among the Hindus of West Bengal region. Garlands can be made from a single type of flower or different flowers in combination. By using needle and thread of cotton, nylon or silk material, the flowers are held together, and in the case of heavy garlands, fine wire strings are used.

5.2.1.2 Floral Bangles and Floral Crowns

These are popular among Indian dancers who also wear them with garlands. The scented flowers used for making such bangles and crowns are jasmine and tuberose, while marigold and *Tabernaemontana* which are non-scented are also used. Earrings and *Bajubandhs* which are also used in ceremonial functions are also made from flowers. For hair decoration, flowers such as *Crossandra* and *Barleria* are widely used in southern part of India for decorating the hair as 'gajra', while other flowers like tuberose, jasmine or *Michelia champaca*, singly or in combination, can also be used. 'Veni', a style of hair decoration by attaching the flowers along the plait of the hair during marriage ceremonies or while performing cultural dances.

5.2.1.3 Rangoli

The creation of beautiful patterns and diverse forms on the floor by using colourful flowers of varying kinds is another contriving innovation among the Hindus in India. This custom of 'rangoli' also known as 'kolam' has a religious overtone and is done during puja in front of temples or in social functions such as marriages and festivals such as Diwali, Onam and Pongal. Petals are mostly used for the purpose of decoration but other plant parts like attractive leaves, creepers and flowers as a whole can also be used.

5.2.1.4 Buttonholes

Buttonholes are also fascinating items for floral decoration by which males wear them in their coat collars at special occasions like weddings and other grand ceremonies. Almost any flower can be used but usually roses and orchids are preferred.

5.2.1.5 Flower Bouquets

One of the many ways of honouring a person in celebration of a special occasion is the presentation of flowers that have been beautifully arranged along with foliage plants tied together to form a flower bouquet. Bouquets are of many types and have different shapes from flat to round, and when arranged in a basket, it is considered to be of higher taste and beauty.

Flat bouquets are made using a hard poster paper in white or any other pleasing colour, and the stem length of each flower is 45–75 cm. Over the poster paper, an aluminium foil or silver paper can be laid to make the bouquets more attractive. The flowers are then laid flat over the paper and held in position using cello tape. Ornamental foliages like thuja, ferns, baby eucalyptus, ivy and asparagus can be used as filler material. Different colours of satin ribbons can be used to tie and decorate the bouquet. For preparing round-shaped bouquets, the flowers are arranged in a whorl to form a cone shape with the stem end becoming tapering, while the flower end comes in a round whorl. Along with the flowers, ornamental foliages may be added to increase its decorative appeal. The base of the bouquet is firmly tied with gunny twine, which is camouflaged with a silk ribbon.

5.2.2 Flower Arrangement

Flowers are a symbol of beauty, love, peace, affection and tranquillity. They are eminently present in ceremonies and gatherings as a requisite for decoration and thus provide an aesthetic appeal to the surrounding. By using various flowers with their different colours to suit the occasion, flowers can be arranged in attractive forms to add variety and excitement to the surrounding. Flower arrangements are also commonly seen as part of home decoration to give out a friendly and cordial atmosphere. A good flower arrangement should have an attractive colour combination and contrast, size, quality, firmness, harmony and distinction.

There are two main styles of flower arrangements:

1. European style: in this style, importance is given on mass arrangement in the form of art only.
2. Japanese style: in this style, every branch, flower and line is well described based on principles taught by philosophers and has deep spiritual significance (Bhattacharjee and De 2005).

The Japanese style of flower arrangement follows three basic lines of traditional ikebana, namely, 'heaven' called shin, 'man' called soe and 'earth' called hikae. Shin is the tallest followed by soe and hikae. A basic style is the moribana, meaning 'piled flowers', in which arrangements are made in shallow containers. This arrangement looks very natural and is often referred to as the natural style of ikebana. Another style called nageire, meaning 'thrown in', needs tall upright vases for making the arrangements. Here also, flowers are arranged as naturally as possible.

There is another method called jiyu-bana (free flowers) which can be arranged in both moribana and nageire styles. While in the latter two cases, generally only those materials that are available in the season are used. In jiyu-bana, one can use combinations of wood, metal or any other material. In zenei-ka (abstract style), the arrangement does not simulate nature. Plant materials are used in combination with any other material that a person can conceive. However, the arrangement should be pleasing and in agreement with the surrounding. There is still yet another style, zenei-bana (avant-garde), which is a piece of art where a beautiful sculpture is created using wood, stone, rock or metals and may depict any natural scenery. Lastly, there is the combination of fruit and flower arrangement which the Japanese call morimono (Randhawa and Mukhopadhyay 2012).

Besides Japanese styles, there can be an all-foliage arrangement, using all foliage types in combination. Presently, interior decorators and flower arrangers have developed finer skills in the art of flower arrangement.

5.2.2.1 Centre Table Arrangement

This kind of flower arrangement requires one to make sure that the floral design holds equal beauty on all sides from any point where it is viewed. It

should also be low enough to provide a clear view to any person who is either sitting or standing. Such arrangements are placed on the centre of tables found in the living room, dining room and passages for the incoming and outgoing people. While designing flower arrangements for centre table, the designer first makes a mental division of two or four sections so the floral material can be divided accordingly. In this way, a uniform design is created that can be observed from all sides. The long-stemmed flower buds are placed at the lower level, while the open blooms are at the top. The same principle is also followed for arranging flowers on the office desk or on the reception table.

5.2.2.2 Side Table Arrangement

Side table arrangements are created with the objective of viewing only from one side of the table, and therefore, the beauty of the floral design is focused on the frontal side of the arrangement. However, before the preparation of the design, other factors should be considered. The size of the decoration should be in proportion with the display table. In order to serve a particular theme, the colour scheme should be determined with caution, also the necessary materials should be properly selected along with the flowers and foliage to express the theme accurately. Such kind of flower arrangement can follow the Western, Indian or ikebana style of flower arrangement.

Flowers with long stems such as tuberose, gladiolus, larkspur and goldenrod are suitable. Leaves of gladiolus, ferns and palms can also be used. The arrangement of flowers and foliage from the boundary towards the centre is usually followed leaving the attractive blooms for the focal point (Bose et al. 1999).

5.2.3 Dried Flowers

With the reality that all living beings perish, including plants and ornamentals that wither away and lose their natural beauty, it has set in the mind of a few to develop a method to retain the appearance of such species and thus the art of flower drying followed. Anything from botani-

cals such as stems, twigs, branches, bark, leaves/ foliage, flowers, thorns/spines, fruits, cones, seeds, roots and minor forest products like lichens, fleshy fungi, mosses, selaginella, ferns, etc. in a dried form comes under the domain of dry flowers (Verma et al. 2012). The varieties of flowering plants that can be employed for drying treatment include globe amaranth, celosia, marigold, etc. Dried flower industry has been identified as a potential area for export, and it constitutes 15 % of global floral business (De 2011). It has been found that the Netherlands ranks first in export of dried flowers followed by the USA, Mexico, India, Columbia and Israel. The export of dried flowers and plants from India is about Rs. 100 crore per year. The USA is the largest consumer of dried and artificial flowers estimated at US\$2.4 million annually, followed by Germany and the UK (Bhattacharjee and De 2005).

Somani (2010) mentioned some of the ornamental flowers that are dried for their colour quality:

- *Red*: cockscomb, peony, pomegranate, sumac, zinnia
- *Pink*: gladiolus, larkspur, peony, snapdragon, statice
- *Yellow*: acacia, goldenrod, marigold, strawflower, yarrow, zinnia
- *Blue*: cornflower, delphinium, globe amaranth, thistle, hydrangea, larkspur
- *Green*: foliage, grasses, seedpods
- *Orange*: marigold, strawflower, zinnia
- *Violet*: gladiolus, heather, lilac, statice, stock

5.2.3.1 Time of Harvesting for Drying

The time of harvest varies from flower to flower, and generally, the flowers that are processed for drying are cut when they have reached maturity but before the colour is deteriorated. An experiment was conducted at TNAU, Coimbatore, and it was found that half bloom (22 days from bud appearance) and full bloom (39 days from bud appearance) are ideal for drying, bleaching and dyeing in *Gomphrena*. Half bloom (18 and 23 days from bud appearance) and full bloom (21 and 29 days from bud appearance) are ideal for drying in French marigold and zinnia, respectively (Lourdsamy 1998).

Roses are preferred at half-bud stage for drying; foliages, when the colour is fresh and clear, are harvested at young age; grasses are cut during their maturity stage and seedpods and cones have to be collected at full maturity before they burst. Vegetables and fruits to be dried should be firm and free from blemishes and infections (Somani 2010).

5.2.3.2 Uses

Dehydrated flowers and plant parts have been used for designing distinctive and artistic greeting cards, landscapes and interior decorative items with dry flowers sealed in glass containers. It can also be used in the preparation of potpourri, flower baskets, twig baskets, front-facing arrangements, mirror frames and table centres. Dry flowers and floral crafts have an everlasting value that can be cherished for long periods if they are protected from moisture and dust. With the fact that they can be maintained and cherished for years without being affected by the harsh winter and the hot summer, the beauty and worth of dried flowers are highly valued.

5.2.3.3 Dried Floral Arrangements

Floral arrangements, using dried flowers and leaves, are known as dry decoration, and they provide more flexibility than the fresh flowers. They are economical as they can be used over and over again, and there is no problem of wilting. The length of the stalk varies between 15 and 40 cm, and it can also be extended by using wire (preferably canes) stalks that are attached with hot glue guns. Dried flower arrangements are classified as 'main blooms', 'liners' and 'exotics':

Main blooms: these constitute the main bulk and play a key role in flower arrangements because of their shape, size and/or colours. Most common species used as main blooms include statice, strawflower, nigella, larkspur and roses.

Liners: the ornamental grasses that are mainly used to provide a linear accent to a flower arrangement are called as liners. Such grasses include *Avena* (animated oats), *Halaris* (canary grass), *Phleum* (timothy) and *Triticale* (orna-

mental wheat). Maize, sorghum, spiked millet, dried branches and twigs of trees and shrubs can also be used in addition to the grasses.

Exotics: from the name itself, we can understand the type of plants that fall under this category. These plants include lotus heads, palm spears and okra pods.

Fillers: these constitute the group of products that are used for adding mass to flower arrangements (Somani 2010).

5.2.3.4 Process of Dehydration of Flowers and Plant Parts

Dehydration is the removal of moisture from any material under artificially produced heat and controlled temperature, humidity and air flow. In the case of living materials, the drying process checks any chemical changes and prevents microbial growth (Bhattacharjee and De 2010). For the preservation of ornamentals and foliage plants, the following methods are mentioned:

5.2.3.4.1 Air Drying

It has often been referred to as 'hang and dry' method, and it is considered to be one of the simplest, easiest and cheapest methods of drying. Flowers like *Helichrysum* (strawflower), *Acrolinum* (paper daisy) and *Limonium* (statice), having a crisp texture, are hung in an inverted position or kept in a container by which they can easily be dried, taking into account that the room should be properly ventilated to avoid rotting of the flowers before they are dried. Other than garden flowers and wild plants, seedpods as well as grasses can also be dried in the same manner.

5.2.3.4.2 Sun Drying

To facilitate quick dehydration, the plant material is embedded in a drying medium in any container after which it is kept under the sun. Sun drying is a common practice for flowers like cornflower, eucalyptus, poppy pods, lotus pods, palm leaves, etc. Also, flowers like marigold, pansy, zinnia and pompon chrysanthemum are dried by embedding them in sand in an upside down manner before they are exposed to the sun. Solar dryers have also been utilised to fulfil the same purpose for most flowers and herbs.

5.2.3.4.3 Press Drying

In this method of drying, the plant parts and foliage are placed in folds or unglazed sheets of newspaper or blotting paper sacrificing the original shape of the plant material. Unless the water vapour completely escapes from the plants, the risk of microbial attack can hardly be prevented resulting in failure of drying and loss of material. Verma et al. (2012) observed that flowers like roses, carnation and helichrysum are press dried at 40–45 °C in an electric hot air oven for 120, 133 and 72 h, respectively, whereas 24 h is optimum for leaves of tuja, *Adiantum* and *Nephrolepis* and flowers of hibiscus, marigold and *Calliandra*. In water drying, ornamentals like hydrangeas, yarrow, bells-of-Ireland and celosia have been reported to dry well by placing the stems initially in a few centimetres of water in a warm, dry and dark location, and the water is allowed to evaporate.

5.2.3.4.4 Embedded Drying

By this method, the original shape, size and colour of the ornamentals are maintained, and the problem of petal shrinking is avoided. The materials used for embedding and drying flowers and foliage should be very fine (0.02–0.2 mm). The flowers and foliage are carefully embedded either in sand or silica gel or borax or in metallic or plastic or earthen containers at room temperature in a well-ventilated room. Solely dependent on weather conditions, drying may prove to be successful, but it is a time-consuming method. Misra et al. (2009) conducted an experiment by which zinnia had been dried by embedding method using electrical oven and microwave oven. It was observed that the size and colour of the flowers remained unaltered both in sand and silica embedding after dehydration with significant loss in flower weight due to loss of water.

5.2.3.4.5 Hot Air Oven Drying

Flowers are placed in an electrically operated hot air oven at a controlled temperature (40–50 °C) and specified duration, depending on the plant size, structure and moisture content of the material, in an embedded condition. This is, undoubtedly, the fastest method of dehydration; however, the disadvantage is that the colour of the plant material is lost.

5.2.3.4.6 Microwave Oven Drying

This is a rapid method of drying plants like snapdragon, China aster, chrysanthemum, etc. with less heat being generated. It is based on the principle of liberating moisture by agitating molecules in the organic substances with the help of electronically produced microwaves (Verma et al. 2012).

5.2.3.4.7 Glycerine Drying

Fresh and fairly matured foliage is treated with hygroscopic chemical with the objective to retain the suppleness of the plant material. The glycerinising chemical is considered to substitute moisture present in the plants responsible for maintaining the foliage form, texture and sometimes the colour.

5.2.3.4.8 Skeletonising

This refers to the removal of all plant tissues with only the veins of leaves intact on the plant. It was found that heavy textured leaves respond better to this kind of technique of preservation.

5.2.3.4.9 Freeze Drying

By the application of heat from solid state (ice) by sublimation, moisture is removed from the plants, which requires high vacuum and low temperature. With a minimum temperature of 12 h, the flowers are dried in a special freeze-drying machine at a temperature starting from –10 °C.

5.2.3.4.10 Predrying Treatment

The retention of texture, shape and overall acceptability of dried flowers depends on the speed of dehydration. A common floral preservative that can be used to improve flower shape and colour is citric acid. It acts as an acidifying agent, thereby lowers the pH of the solution and also prevents the blockages of xylem vessels and helps to improve flower size, shape and colour.

5.2.3.4.11 Care After Drying and Dehydration

Dried flowers and foliage require proper care and maintenance as they are very delicate, brittle and fragile. After press drying, the dried flowers

are stored either in a dry location or in desiccators till they can be used. In the case of embedded drying, the containers are tilted to remove the desiccants, and the dried flowers are carefully picked and dusted with a fine hair brush to remove the remaining desiccants. To prevent microbial attack on the dried products, a small quantity of silica gel should be placed inside the container to absorb moisture. Also, storage containers should be dust-free. Mothballs should be kept in storage containers to protect them from insect attack.

5.2.3.5 Colouring of Flowers

5.2.3.5.1 Tinting

In cases where the flower pigment is absent, light or dull in colour, an eminent technique has been developed by artificial colouring of flowers using edible dyes and stains such as food colours, Feulgen stain, bromocresol blue, bromocresol green, eosin yellow, ammonium purpurate and phenol red. Red-, blue-, green- and yellow-coloured flowers can be obtained from white flowers of tuberose, spider lily, candytuft and white ixora. Other flowers with the potential for tinting are white gladiolus, different orchid species, loose flowers of jasmine, crossandra, chandni, etc. (De 2011).

5.2.3.5.2 Bleaching

According to Somani (2010), bleaching and dyeing are the two important processes related to commercial dry flower production. It involves chemical processes that can change the ability of colour bodies to absorb light by changing their degree of saturation (Verma et al. 2012). In bleaching, both oxidative and reductive bleaches are available, of which the level of efficiency depends on the measure of accessibility of bleach to lignin. Some of the commonly used oxidative bleaches are sodium chloride, hypochlorite and peroxidise, and reductive bleaches are sodium sulphide, hydro-sulphite and dioxide. Sodium chlorite (10 %) is an effective bleaching agent for Gomphrena followed by hydrogen peroxide (30 %) (Lourdusamy 1998).

5.2.3.5.3 Sulphuring

In sulphuring, sulphur dioxide acts to bleach coloured plant material and, below a certain concentration, to fix red colour in some flowers. Colour fixation is associated with acidification of the tissues.

5.2.3.5.4 Dyeing

For increasing the aesthetic value, dyes can be applied to the fresh, dried or bleached ornamental plant parts, as per the changing seasons and fashions. The most widely applied technique of dyeing is the immersion of the plant material into the suitable dye. Immersion dyeing is improved by removing the waxy cuticle with NaOH from the dried plant material and by adding surfactants to improve the contact between the dye bath solution and the plant material. In addition to dyeing (staining), the plant material can also be painted and commonly silver or gold paint is used (Bhattacharjee 2006).

5.2.3.6 Potpourri

Potpourri is a mixture of dehydrated flowers, berries and leaves, seeds, stems and roots (De 2011). Dried flowers, herbs, grasses and to a lesser extent seedheads are used by florists to design the semi-permanent, maintenance-free beautiful decorative arrangements and the potpourri mixes (Bose et al. 1999). The basis of a potpourri is the aromatic oils located within the plants (De 2011). Thus, the design and making of potpourri is based on the principle that these aromatic oils are slowly released into the atmosphere which gives a pleasing aroma to the surrounding. The two types of potpourri that are available are wet and moist, both of which require a fixative to absorb the aromatic oils, after which they are gradually discharged. The materials that are selected for the preparation of this special kind of dry flower arrangement should be resistant to mould, non-toxic, free from noxious odours and sufficiently robust to withstand mechanical bending.

Some of the common fixatives that are used in the preparation of potpourri are finely ground non-iodised salt, orris root, sweet flag, gum, benzoin, storax and ambergris. In our country, the major flowers like marigold, rose and bougainvillea are

used with globe amaranth and cockscomb. These flowers and flower parts are contained in a beautifully designed glass bowl with different colours and shapes or they are packed in a colourful satin or muslin sachet. Potpourris have been prepared not only for the purpose of creating sweet fragrance but also to repel moths and protect woollen clothes in storage.

5.2.4 Perfume and the Components Constituting the Perfumery Industry

Perfume is a mixture of fragrant essential oils, aroma compounds, fixatives and solvents used to give the human body, animals, objects and living species a pleasant scent (Verma et al. 2012). It is a man-made product that contains odoriferous compounds that give out a pleasing aroma.

5.2.4.1 Essential Oils

An essential oil is a concentrated, hydrophobic liquid containing volatile aromatic compounds from plants and its parts (Verma et al. 2012). These are chemical compounds of an odoriferous nature, which are highly volatile, insoluble in water but soluble in organic solvents. They contain mixtures of organic compounds belonging to different classes of compounds such as terpenes, phenols, phenyl terpenoids, aliphatic compounds, etc. (De 2011). The chemical constituents by which essential oils are made of have been classified as non-oxygenated and oxygenated hydrocarbons. The non-oxygenated hydrocarbons are hydrocarbons of terpene class and are of little importance in perfumeries. Alcohols, aldehydes, ketones and ethers form the group of oxygenated hydrocarbons (Bhattacharjee et al. 2005).

Essential oils are derived from natural raw materials that are the various parts of a plant, e.g. leaves, flowers, bark, roots and seeds (Verma et al. 2012). Many essential oils constitute one, two or three major compounds that are responsible for the particular fragrance used in the perfumery industry such as citral in lemongrass and *Litsea cubeba* oil, citronella in *Eucalyptus citriodora* and Java citronella oils. The major flowers that are

used for the extraction of essential oils in India are jasmine, rose, chamomile and clary sage. In jasmine, *J. sambac* and *J. grandiflorum* yield 0.15 % concrete and 55–62 % absolute. Among the rose species, *Rosa damascena*, *R. bourboniana*, *R. centifolia*, *R. moschata*, *R. gallica* and *R. alba* are used for the extraction of oils on a commercial scale. The best quality essential oil in the world is obtained from *R. trigintipetala* (0.03 %). Other important sources for perfumery are sandalwood, vetiver, palmarosa, cypress, etc. (De 2011).

For the extraction of essential oil, the flowers are harvested at the stage when they are fully open, in the early hours of the day. Delay in picking would result in a loss of concrete yield. Furthermore, to prevent any discolouration and yield loss, the flowers should be carefully handled after harvest.

The methods by which the essential oils are extracted from these are mentioned below:

5.2.4.1.1 Steam Distillation

In this method, pressurised steam is allowed to pass through the fresh flowers that are kept in a plant chamber, and the heat produced forces out the volatile oil from the plant cells which also get evaporated along with the steam. After condensation, the oil is separated while the distillate can be used as floral water.

5.2.4.1.2 Solvent Extraction

The extraction of essential oils with solvents such as petroleum ether or benzene is practised whenever the oil with its natural flavour is required. Here, the plant material is saturated with the solvent that releases the aromatic compounds. After the extraction process, the solvent is filtered and concentrated by heating at a constant temperature of 75 °C till it gets evaporated off leaving behind the perfumery compounds.

5.2.4.1.3 Enfleurage or Cold Fat Extraction

This is an, comparatively, older method where flowers like jasmine, tuberose, violets, etc., that usually produce essential oils even after they are picked, are placed over a blend of fats, which absorbs the oils and fragrances of the flowers. After a number of days, the flowers are replaced by fresh ones until the fat is saturated. The vola-

tile oils are then separated from the fat by treatment with alcohol.

5.2.4.1.4 Maceration

In this method, the plant material is chopped and digested with hot oil at 45–80 °C for several hours, during which successive batches of the new flowers are added to the filtrate up to 20 times. Finally, the essential oil is collected separately by treatment with alcohol.

5.2.4.1.5 Expression

Here the fruits are compressed or squeezed in claw-shaped bowls where the juice is sucked out of the fruit through a cannula inserted in the pulp, while the oil released is rinsed with water and separated by centrifugation.

5.2.4.1.6 Adsorption

In this process, hot air or inert gas is passed over the aromatic plant material which is then led through the activated carbon from which the essential oils are recovered by solvents (Bhattacharjee and De 2005).

5.2.4.1.7 Uses of Oils and Their Share (Verma et al. 2012)

Uses of oils	% share
Flavours in food industry	55–60 %
Fragrance in perfumes or cosmetics	15–20 %
Pharmaceutical preparations as starting material	15–20 %
Natural products	5–8 %
Isolation of aroma	15–20 %

5.2.4.1.8 Applications

Essential oil	Application
Geranium, ylang-ylang	Perfumery compounds
Orange, peppermint	Flavouring industry, essences
Clove, aniseed	Antiseptic oils
Cinnamon, ginger, pepper	Snack food industry
Rose, <i>kewra</i> , sandalwood, peppermint	Chewing tobacco industry
Lavender, rose, jasmine	Aromatherapy and <i>agarbatti</i> industries

5.2.4.2 Flavours and Fragrances

In an effort to affect one's mood and promote health, certain fragrances are derived from the petals of selected flowers which produce oil-based compounds of alcohols and sugars surrounded with glucose which causes the formation of scentless glucosides. A distinct aroma is detected when the glucoside is hydrolysed by enzymes, and the scent increases with additional moisture. Chemical constituents responsible for fragrance are rhodinol in rose, geraniol in geranium, nerol in magnolia and eugenol in clove. Compounds that contribute to the essence are terpenes, esters, aldehydes, ketones, alcohols and phenols, each of which possesses antimicrobial effects and medicinal properties. Esters are fungicidal and sedative; aldehydes are lemon scented and are sedative; ketones help in congestion and respiratory complaints. Among alcohols, linalool is the most common, and these are antiseptic and antiviral in nature. Eugenol, carvacrol, anethol and estragole are the major phenolic compounds and are bactericidal in nature.

Fragrances are used in the manufacture of soaps, detergents, creams, lotions, hair oil and other cosmetics. Fragrances are also used in leather and rubber textiles, as well as in plastics and craft papers.

Flavour is actually a combination of odour and taste. Characteristic flavours can be obtained from different cultivars or species of a flower crop from which the essential oil can be extracted. For example, among the rose cultivars, apple flavour is obtained from *Rosa eglanteria* (fragrant sweet briar rose) and *Rosa wichuraiana* (memorial rose); balsam flavour from *Rosa rugosa rubra* (red Japanese rose), *Rosa gallica* (French rose) and *Rosa damascena* (damask rose) and honey and musk from *Rosa moschata* (musk rose), *R. multiflora* (baby rose or Japanese rose), *R. arvensis* (field rose) and *R. sempervirens* (evergreen rose). For flavouring biscuits, mint, rosemary, thyme and sage are used and rose petals, sage, rhubarb, mint, bay leaf and lavender for jams, jellies and puddings.

5.2.5 Phytochemicals

Xanthophylls, carotenes and flavonoids, namely, anthocyanin, flavonols and flavanones are secondary metabolites specially known as phytochemicals as they impart taste, aroma and colour to the food as well as having pharmaceutical and nutraceutical properties that can be used in medicine and agriculture. They are strong antioxidants and are mostly involved in photoreception and photoprotection.

Marigold is utilised for the extraction of important phytochemicals like lutein and zeaxanthins which are effective against cancer, heart disease, cataract and age-related nuclear degeneration. Lycorine and tazettine from dried bulbs of *Narcissus tazetta* (narcissus) have antiviral and antileukemic properties. Dahlia tubers are rich in insulin and fructose, phytin and benzoic acid and are effective against diabetes. *Calendula officinalis* contains celandine, flavonoids, polysaccharides and pectic substances and is used for the treatment of fever, ulcers, burns and wounds.

From orchids, loroglossin is the most common glucoside that has been isolated from different species. Dendrobine from *Dendrobium nobile*, malaxine from *Malaxis congesta* and phalaenopsin from *Phalaenopsis manni* are other phytochemicals obtained from orchid species (De 2011).

5.2.6 Plant Pigments

Pigments responsible for colours of flowers are carotenoids, chlorophylls, anthocyanins and anthoxanthins. The carotenoids are a group of orange, yellow and orange-red fat-soluble pigments. These contain hydroxyl groups called xanthophylls and occur as esters of fatty acids. Chlorophylls are also fat-soluble pigments like carotenoids. They are of two types, chlorophyll a and chlorophyll b, and occur in plants in the ratio of 3:1.

Flavonoids are a group of compounds distributed in the plant kingdom which are water soluble and consist of anthocyanins that are red, blue

and purple pigments. The anthoxanthins are orange to yellow in colour and are water soluble.

Some of the different pigments isolated from their respective ornamental plants are as follows:

- Pelargonidin: dahlia, geranium, verbena, tulip, petunia
- Cyanidin: dahlia, petunia, lily, chrysanthemum, dendrobium, rose, petunia
- Petunidin: petunia, parash (*Thespesia populnea*)
- Lutein: marigold, *Hemerocallis* (day lily)
- Anthocyanin: sweet pea, tulip, zinnia, euphorbia
- Delphinidin: tulip, lupine, petunia, rhododendron
- Quercetin: rose, waterlily, sweet pea, camellia

5.2.7 Natural Dyes

Dyes are colourants or colouring substances that are added to something to change its hue or colour. Chemically, dyes are benzophenones, glycosides, quinines and flavones. Apart from the application in the food industry, dyes are used as colouring agents in paints, ink, leather, wood, paper, fur, cosmetics, medicines and toothpastes. They can also be applied to fresh, dried or bleached ornamental plant parts in order to increase their aesthetic value as per the changing seasons and fashions.

Yellow-coloured dyes extracted from chrysanthemum are used in cosmetic and food industry. They are also derived from flowers of golden rod (*Solidago canadensis*) which have also been used for the preparation of cosmetics. The dye extracted from the leaves, bark and fruits of *Cassia auriculata* is used in the leather-tanning industry. An orange-red dye used in cosmetics and medicine has been derived from the arils of *Bixa orellana*. Marigold yields a yellow- and orange-coloured dye that can be used in food industry and poultry feed. Henna (*Lawsonia inermis*) leaves produce orange dyes that are used in cosmetic and leather-tanning industry.

5.2.7.1 Extraction of Orange-Red Dye from *Bixa orellana* (Annatto)

A fine suspension of colouring matter is obtained by soaking the seeds along with the adhering pulp in hot water for several hours. The seeds are removed and the liquid is allowed to ferment for a week until the dye is settled at the bottom. The sediment that has thickened is dried and cut into small cakes. For procuring the pure form, the red pulp is dissolved in an organic solvent like chloroform and evaporating the solvent to get a paste-like matter. This type of dye is used in soaps, pomades, fabrics, paints, varnishes and burns.

5.2.7.2 Extraction of Red Carthamine and Safflower Yellow from *Carthamus tinctorius* (Safflower)

The dried florets of safflower are repeatedly washed with acidulated water to get the water-soluble safflower yellow. Carthamine, the water-insoluble orange-red dye, is extracted by treating the leftover residual mass with sodium carbonate which is then precipitated out using dilute acids. The dye can be used as a substitute for saffron, and it produces different shades of colours, cherry red, rose pink, crimson or scarlet used in cotton and silks. It is also used for colouring cakes and biscuits.

5.2.7.3 Extraction of Blue Dye from *Indigofera* sp. (Indigo)

The dye, indigotin, is extracted by crushing and immersing the freshly cut plants in water for 10–15 h in 'indigo vats'. Woad leaves (*Isatis tinctoria*) are added to enhance the fermentation process for the conversion of soluble indigotin to indigo white. The liquid is then agitated continuously by passing through beating or oxidising vats equipped with paddle wheels, and the operation is stopped by heating as soon as the blue colour develops. The blue dye settles at the bottom and the liquid is drained off. The bluish mass is further granulated by boiling with water. The filtered sludge is pressed and cut into small tubes after which they are air dried and graded. Indigo

is utilised for dyeing and printing cotton, rayon and also for dyeing wool.

5.2.7.4 Extraction of Orange Dye 'Henna' from *Lawsonia inermis* (Henna)

The dried leaves are the primary source for the extraction of the dye which is obtained in the form of a powder, after which it is mixed with water and applied to the parts needed for dyeing. It is harmless and does not cause any irritation to the skin. It is also used for colouring leather, and the oil, obtained by steam distillation, has been used for making perfumes since ancient times (Bhattacharjee and De 2005).

5.3 Value Addition in Commercial Flowers

5.3.1 Rose

Rose is one of the most beautiful perennial flowering plants having different growth habits (shrub, climber or trailing plant) displaying a diversified range of colours and different shades of white, yellow, pink, orange and red. These are perennial in nature and are native to the Himalayan regions of Asia.

5.3.1.1 Value-Added Products

1. *Rose water*: it is prepared by boiling the flower petals with water and collecting the condensed steam which is used as sherbets or as cleansing lotions, eye drops, etc.
2. *Rose oil or attar of rose*: this constitutes the essential oil extracted from the rose along with the wax that has been collected from the petals. It is transparent pale yellow or yellow grey in colour and is generally obtained from *Rosa centifolia* and *Rosa damascena*. Rose oil has its use in the perfumery and cosmetic industry.
3. *Concrete*: essential oils that have been extracted by solvent method using petroleum spirit or hexane and evaporated at low

temperature and under reduced pressure yield a reddish brown waxy solid known as concrete. The range of concrete recovery is 0.18–0.30 % and is highly valued in the perfumery industry.

4. *Gulkand*: rose petals and sugar are mashed together in the ratio of 1:2 and dried in the sun. The gulkand that has been prepared is used as a laxative and also as a flavouring agent.
5. *Pankhuri*: rose petals that have been dried under a shade are used in preparation of cool summer drinks and incense.
6. *Rose hips*: the fruits of this plant are called as rose hips, and they are a rich source of vitamin C, pectin (11 %) and (3 %) a mixture of malic acid and citric acid. They contain laxative and antidiuretic properties and also help prevent cancer and cardiovascular diseases as they contain important phytochemicals like carotenoids, plant sterols and tocotrienols and a high level of anthocyanins, catechins and other polyphenols. Rose hips are used for preparing apple sauce, soups, puddings, jam, jellies, etc.
7. *Rose tea*: dried and crushed rose hips are used for making herbal tea that promotes health by preventing digestive tract infection and skin diseases.
8. *Medicinal roses*: *Rosa centifolia* and *Rosa damascena* have medicinal properties in which the roots are used for treating intestinal disorders, rickets, diarrhoea and haemorrhages. The leaves are used to treat wounds, ophthalmia, hepatopathy and haemorrhoids. The flowers are emollient, expectorant, cardiotonic, anti-inflammatory, digestive, carminative and antidiarrhoeal.

5.3.2 Chrysanthemum

Chrysanthemums are herbaceous annuals that occur as single or spray types with large flower heads having a wide range of colours from white, yellow to pink. They are commonly known as ‘mums’ and are native to Asia and North East Europe.

5.3.2.1 Value-Added Products

1. *Garlands*: varieties that are specially used for the purpose of making garlands are ‘Indira’, ‘IIHR-Sel-5’, ‘IIHR-Sel-6’, ‘Jaya’, ‘Shanti’, ‘Red Gold’ and ‘Meera’.
2. *Potpourri*: dried flowers of yellow or white mums are used for providing a soft aroma and decorative purpose.
3. *Edible chrysanthemums*: sweet drinks can be prepared by boiling the yellow or white flowers of chrysanthemums and are common in Asia. Tea made from these flowers is effective against influenza. A rice wine that has been flavoured with chrysanthemum flavours is popular in Korea and is known as ‘gukhwaju’.
4. *Chrysanthemum insecticides*: pyrethrin, an active component that can be extracted in the form of oleoresin by pulverising the flowers of *Chrysanthemum cinerariifolium* (pyrethrum), is contained in the seeds and applied as a suspension in water or oil or as a powder. These are used as safe insecticides as they are biodegradable and nonpersistent.
5. *Medicinal chrysanthemum*: chrysanthemum extracts are rich in alkaloids, volatile oils, sesquiterpene lactones, flavonoids, choline, chrysanthemine and vitamin B1 and have proven to contain antibacterial and antimycotic properties and have the potential to combat HIV. They are also used for treatment against eye infections, fever, headaches, bad breath, etc.

5.3.3 Carnation

It is an herbaceous perennial. The plant grows to a height of 80 cm producing glaucous greyish green to blue-green slender leaves, and the flowers occur singly or as a cluster in a cyme which are sweet scented and are red, white, yellow and green in colour.

5.3.3.1 Value-Added Products

1. *Carnation concrete and absolutes*: the concrete recovered from the petals of these flowers ranges from 0.2 to 0.3 %, and when treated

with alcohol, it yields carnation absolute, which are both used for perfumery.

2. *Dry flowers*: carnation flowers are quick to dry (3–5 h) and are commonly used for floral decoration and dried flower arrangements. They are also used as potpourri, scented sachets and cosmetic products.
3. *Medicinal carnations*: the carnation flowers are utilised in the medicinal field to treat kidney and bladder problems, skin infections and constipation. It has been reported as an alexiteric, antispasmodic, cardiotoxic, diaphoretic and nervine. They have also been effective against poisoning, muscle spasms, heart diseases and nervous breakdown.
4. *Edible carnations*: the flower petals of carnation are clove scented and candied and are generally used for garnishing and flavouring in salads.

5.3.4 Anthurium

Anthuriums are herbaceous perennial plants and are characterised by the presence of colourful spathe and hundreds of small flowers that form the spadix. They are commonly known as flamingo flower and belong to Araceae family of the plant kingdom.

5.3.4.1 Value-Added Products

Generally grown as potted plants or cut flowers, they are found to make beautiful flower arrangements and bouquets and for other decorative purposes. The spathes are available in varying colours from green, white, cream, orange to pink:

1. Standard anthuriums: they are characterised by their heart-shaped spathes.
2. Obake anthuriums: they are bicoloured, generally green with a distinct spathe colour.
3. Tulip anthuriums: these are upright cup-shaped spathes with an erect spadix.

5.3.5 Gerbera

Commonly known as ‘African daisy’ or ‘Transvaal daisy’, these plants are herbaceous

perennial, grow to a height of 60–70 cm bearing a large capitulum with striking, two-lipped ray florets in yellow, orange, white, pink and red colour.

5.3.5.1 Value-Added Products

These flowers are excellent for flower arrangements and preparing attractive bouquets as they have a longer keeping quality as compared to other cut flowers. They are generally grown as border plants, in flower beds and containers or window boxes. They also possess medicinal value as they act as effective antispasmodic, anodyne and antitussive.

5.3.5.1.1 Gladiolus

These are perennial bulbous flowering plants which produce sword-shaped longitudinal grooved leaves enclosed in a sheath with flower spikes that are large and one-sided; hence, they are known as ‘sword lily’. The flowers are bisexual, each subtended by green bracts and have a diversity of colours from pink to reddish or light purple with white markings or white to cream or orange to red.

5.3.5.2 Value-Added Products

1. *Bouquets*: the flower spikes used for this purpose should be harvested in the morning or at night when only two to three flowers have opened.
2. *Flower arrangement*: they make spectacular flower arrangements, but one should keep in mind to add floral preservatives to the vase water before arranging the flowers.
3. *Medicine*: it is commonly used in Africa for treating dysentery, constipation and diarrhoea. It is also used as an energy booster and prescribed for hypochondriacs.
4. *Edible gladiolus*: the corms of *G. edulis* and *G. dalenii* can be consumed as food by boiling them in water.
5. *Scented gladiolus*: *G. callianthus* having irregularly petalled white flowers, with a dark purple patch at the centre, is delicate and highly scented species of this genus.

5.3.6 Tuberose

The perennial bulbous flowering plants produce clusters of white waxy fragrant flowers that bloom at the top of the spike. The bright green leaves grow in a cluster at the base and also as clasping leaves along the stem. They are commercially cultivated as cut and loose flowers in the tropical and subtropical regions.

5.3.6.1 Value-Added Products

1. *Floral ornaments*: tuberose is commonly used for preparing garlands, venis, floral bangles, earring and floral crowns. They are also used for decorative purposes in wedding ceremonies and traditional rituals.
2. *Essential oils*: essential oil of tuberose, extracted from the petals through solvent extraction method, contains eugenol, benzyl alcohol, farnesol, butyric acid, methyl benzoate, nerol, geraniol and methyl anthranilate. Usually, 1,150 kg flowers yield 1 kg absolute and concrete recovery ranges from 0.08 to 0.11 %.
3. *Medicines*: the fragrance of tuberose is known to relax the mind and it enhances the blood circulation. The oil obtained from it is used to treat skin infections, nausea, vomiting, etc.
4. *Edible tuberose*: in Indonesia, the flowers are cooked and used in preparation of vegetable soups and sauce.

5.3.7 Jasmine

Jasmine is a woody shrub, climbing or trailing vine which can grow up to a height of 3–4.5 m producing highly fragrant white or yellow flowers.

5.3.7.1 Value-Added Products

Essential oils: the scented oil obtained by steam distillation from the flowers of *J. occidentale* and *J. grandiflorum* is non-toxic and nonirritant and is rich in linalool, eugenol, benzyl benzoate, benzyl acetate, methyl anthranilate, indole and others. These are valuable in the cosmetic and perfumery industry for making

perfumes, incense, soaps, shampoos and creams.

Herbal medicines: the different plant parts such as flower, leaves, stems, seeds and roots are useful in the pharmaceutical industry. The flowers are effective against jaundice and other venereal diseases; the flower buds are treatment against ulcers, vesicles, boils, skin diseases and eye disorders. The leaves can be used to treat breast cancer and mouth ulceration. The oils are antidepressant, antispasmodic, antiseptic, sedative anti-daturine, etc.

Jasmine tea: the flowers of *J. sambac* are used for the preparation of tea in China and Japan.

Jasmine syrup: jasmine scones and marshmallow (*Althaea officinalis*) are popular among the French which are prepared from the extracts of jasmine flowers.

Hair decoration: the fragrant flowers are used in decorating the hair of women as floral crowns or venis.

5.3.8 Marigold

Marigold is an herbaceous annual or perennial and produces flowers having both disc and ray florets in *varying shades of yellow and orange*.

5.3.8.1 Value-Added Products

1. *Phytochemicals*: marigold flowers are a rich source of terpenoids, flavonoids, carotenoids and thiophenes that have found varied uses in preparation of medicines and insecticides.
2. *Natural dyes*: a yellow cloth dye known as 'egandai' or 'gandia' is extracted from the flowers of *Tagetes erecta* and produces bright colour with mordants.
3. *Industrial application*: the essential oils are widely used in the preparation of soaps, detergents, disinfectants, mosquito repellents, flavourings of food, etc.
4. *Edible products*: *T. lucida* are used in salads and as an aromatic herb which is added to soups, sauces, chicken dishes, etc.; the leaves are also used in the preparation of herbal tea.

5.4 Value Addition in Aquatic Plants

Aquatic plants are indispensable components of natural water bodies that absorb minerals and carbon dioxide in the water. They are classified as oxygenators, marginals, floaters and deep aquatics. Oxygenators release large quantities of oxygen in the water, e.g. buttercup and water violet, while marginals are those ornamentals that are planted in pots or baskets at the edge of the ponds, e.g. *Primula*. Floaters like water hyacinth help prevent growth of algae and provide enough cover for tadpoles and fish and deep aquatics like water hawthorn or waterlilies, aponogeton, *Nuphar*, etc.

There are also aquatic plants that act as vegetative filters that take up ammonia, nitrate, phosphate and even toxins through their roots and keep the water free from solids and chemicals. Such plants include water hyacinth, water lettuce, watercress, waterlily, cattail, sweet flag, etc.

Edible aquatic plants: the leaves of aquatic mint, bacopa, Vietnamese cilantro and water spinach, the tubers of arrowhead, duckweed, lotus and taro and all parts of perennial rice, water celery and watercress are eaten.

Medicinal aquatic plants: the leaves of pennywort (*Hydrocotyle* spp.) are used for treating arthritis, and marshmallow acts as a cough suppressant and wound healer.

Aquatics for decoration: plants like *Nelumbo nucifera* are offered to the gods in the temples.

Ornamental aquatics: *N. nucifera*, *N. pubescence* and *Eichhornia crassipes*.

5.5 Value Addition in Cacti and Succulents

The group of plants belonging to the family Cactaceae and many other plants belonging to the genera *Agave*, *Aloe*, *Cotyledon*, *Echeveria*, *Euphorbia*, *Haworthia*, *Kalanchoe*, *Sansevieria*, *Sedum* and *Sempervivum* comprise the family of succulent plants as they have the characteristic

ability to store water and thus help them to survive for extended period, especially during droughts. While all cacti are succulents, not all succulents are cacti (Bose et al. 1999).

The white-, cream-, yellow-, dark orange-, vermilion-, dark red-, bright purple- and blood red-coloured flowers of cacti are hermaphrodite, stalked or sessile and bell shaped and develop from the upper portion of the areoles. Some may bloom during the day while some bloom at night.

5.5.1 Importance and Uses

Cacti are used in beautifying the landscape and are suitable as potted plants, for hanging baskets, miniature gardens, window garden, rock garden, trough garden, dish garden, bowl garden, tray garden and desert garden:

Fragrant cacti: *Astrophytum myriostigma*, *Echinocereus luteus*, *Echinopsis campylacantha*, *Epiphyllum darahii*, *Hylocereus extensus*, *Nyctocereus serpentinus*.

Cacti for indoors: *Chamaecereus silvestrii*, *Gymnocalycium mihanovichii*, *Echinocereus procumbens*, *Mammillaria* spp., *Opuntia microdasys*.

Cacti for bowl garden: *Cleistocactus strausii*, *Chamaecereus silvestrii*, *Echinocereus grusonii*, *Mammillaria elongata*, *Opuntia pilifera*.

Edible cactus: edible cactus is characterised by its fleshy leaves called pads and is commonly known as nopales, nopalitos, cactus paddles or cactus pods. These are rich in beta-carotene, iron, vitamin B, vitamin C and calcium. They can be eaten raw or cooked. The leaves of *Pereskia aculeata*, the pulp of *Echinocactus horizonthalonius*, the stem and pulp of *Ferocactus wislizeni* and the stem, flower buds and flowers of *Opuntia basilaris*, *O. dejecta* and *O. clavata* are consumed as food. Cacti that can be used for the preparation of beverages are *Carnegiea gigantea* and *Opuntia megacantha*.

Among succulents, there are those that are edible such as *Adansonia gregorii*, *Bombax ceiba* var. *leiocarpum*, *Brachychiton populneus*, *Calandrinia balonensis*, *Dioscorea bulbifera*,

Doryanthes excelsa, *Portulaca bicolor*, *Portulaca oleracea*, *Sarcozona*, *Tetragonia decumbens*, etc. Some of the succulents are also found to have medicinal properties, e.g. the boiled leaves and roots of *Aloe ferox* (cape aloe) are used as laxative, arthritis, eczema, conjunctivitis, hypertension and stress; the pulp obtained from the fruit of *Adansonia digitata* is effective against fever, diarrhoea and haemoptysis; and the tubers of *Dioscorea* spp. are used to treat hysteria, convulsion and epilepsy.

5.6 Value Addition in Some Ornamental Orchids

Orchids are perennial herbs and unlike most plants, they do not grow in soil but on rocks (lithophytes), trees (epiphytes) and even on decaying organic matter (saprophytes). They possess aerial roots that have a special covering of loose and spongy tissue called 'velamen' which absorbs moisture and nutrients that wash over them. Orchids are grown mostly for their flowers, but the seedpods of the vanilla orchid provide the characteristic flavour and aroma in foods and cosmetics.

Orchids are grouped into two major categories – monopodial and sympodial orchids. Monopodials are those in which the stem has an unlimited apical growth, and the roots are not restricted to its basal portion, e.g. *Phalaenopsis* and Vanda, while sympodials do not have a single upright stem but rather, they have a more or less horizontal growth habit that consists of a pseudobulbs that can store water and thus survive without water for a long duration, e.g. cattleya, cymbidium, oncidium and dendrobium.

5.6.1 Value-Added Products

Orchids are commonly used in decorations for various occasions such as wedding ceremonies, and they also make beautiful flower arrangements. The attractive flowers and foliage have been used for making attractive floral ornaments like corsages and boutonnieres. Corsages can be

creatively and distinctively be worn on wrist, ankle or neck or decorate shoes, handbags, hair, hats, etc. Boutonnieres are worn by men on the left lapel of suits. Orchids like Cymbidium, Dendrobium, Oncidium, *Paphiopedilum* and Odontoglossum make beautiful corsages and boutonnieres.

Some orchids are also used as medicine due to their healing properties. The uses of dried orchids range from immune system build-up, cancer treatment, eyesight improvement, fever, etc. and have been widely exploited in China. The parts mostly used are the stems and bulbs as they contain nutritive substances. For example, *Bulbophyllum odoratissimum* is used to treat tuberculosis, chronic inflammations and fractures. *B. inconspicuum* is used as an expectorant and is effective against stomach cancers.

Vanilla is a popular species that have been utilised in the flavouring industry to prepare foods and beverages. In Bhutan, *Cymbidium hookerianum* has been used for flavouring curries, giving the food a slight bitter flavour. The fragrant leaves of Dendrobium have been used as a condiment for rice in Malaya.

Dendrobium catenatum canes are boiled and drank as tea for rejuvenation of strength after an illness. The leaves of *Dendrobium chrysotoxum* are dried and also drank as a herbal tea.

Some of the orchids are also consumed as vegetables such as, Dendrobium, whose flower is consumed as a fried dish in Thailand and is used for garnishing cakes and desserts in European countries.

5.7 Conclusion

Value addition has become an important component of the floricultural industry. New products and processes, including innovative methods, are continually being devised. Standardisation of techniques for the production of pigments, essential oils and natural dyes from flowers and the potential crops for these purposes should be carefully evaluated. The principal objective of value addition is to increase the value of raw materials and deliver to the customers unique

products as per the needs and demands of the market. Some of the factors that require consideration, when one has undertaken such a complex enterprise, are the methods of storage, packaging and transport to the local or distant market to preserve the quality of the product and thus promote profitability. With proper planning and management skills, value-added products can generate higher return, open new markets, create brand recognition and add variety to farm operation.

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