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Report and Opinion

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Dry flowers

Saima Rashid Mir

Abstract: Fresh flowers are appealing and attractive, but maintaining their allure and fresh appearance for an extended period of time is difficult. To overcome this problem, the same flowers can be dried and processed into dry flowers that last indefinitely. Innovative ideas capable of providing solutions to social problems can be turned into money-spinning business opportunities. The dried flowers obtained can be used in various ways to produce significant items and would thus be able to assist with saving the climate from contamination caused due to improper disposal of flower waste. Dry flowers are the key components of the floriculture industry, which are rapidly rising in international trade. The dry flower industry is offering a big opportunity for the national economy in diversified dimensions by creating job opportunities and entrepreneurial development. Dry flowers are modest, extensive, and hold their aesthetic worth regardless of the period. Dried flowers and unused plant materials are offering opportunities for entrepreneurship by using dry flower technology. Practically all flowers, including leaves and other botanicals, can be viably dried with various drying methods. Apart from flower structure and time of collection, the quality of dried flowers incredibly relies upon the method of drying. Various methodologies needed for the production of dried alluring plant material incorporate air drying, press drying, embedded drying in desiccants, microwave oven drying, hot air oven drying, water drying, glycerin drying, and skeletonization. The information and knowledge gathered in this book may be useful in drawing the consideration of researchers to work on it. Other than that, business people can directly utilize the knowledge in the study as the suitable drying methods and approximate drying time for a variety of flowers and foliage have been enlisted in this book.
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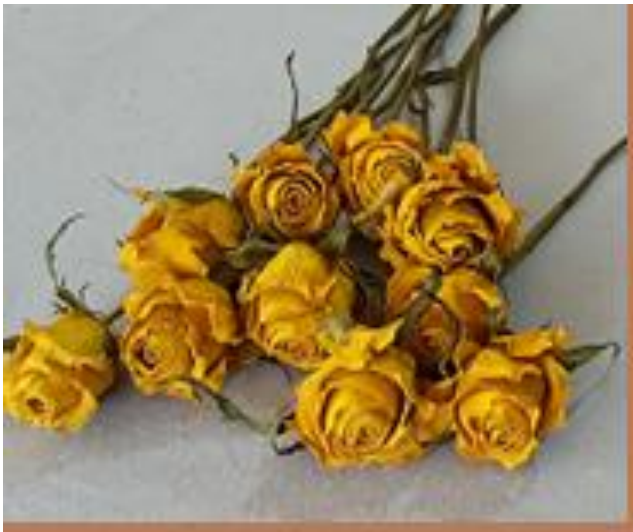
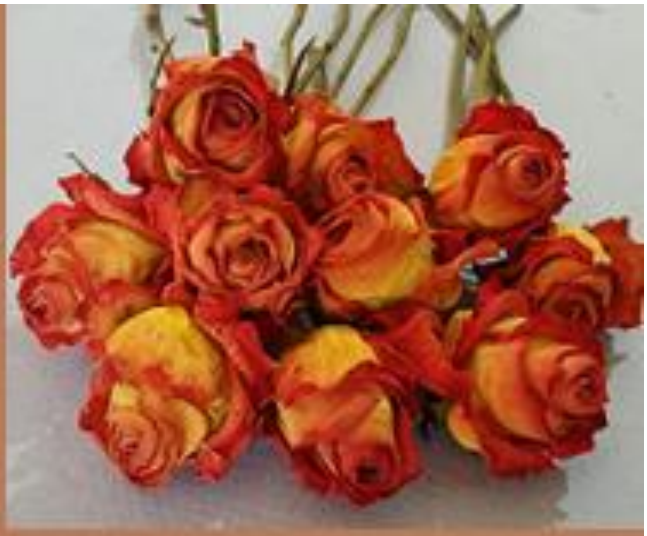
Key words: Dry flowers, Dryingmethods, Preservation, Skeletonization, Eco-friendly, Value addition, Employment generation.

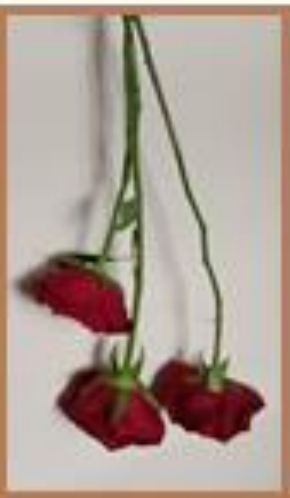


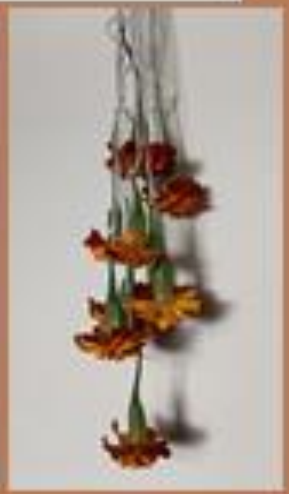


Dry Flowers

Dry Flowers & Dry Flower Products: The Process of Money Generation from Neglected Plants

Saima Rashid Mir





Contents

1. Importance of Floriculture in India

Floriculture is an ancient Indian farming activity with enormous potential for generating profitable self-employment among small and marginal farmers. The commercial production of cut flowers, nursery plants, potted plants, cut foliage, seeds, bulbs, tubers, rooted cuttings, and their use in value-added products are all part of India's floriculture business. In recent years, it has emerged as a profitable agri-business in India and around the world, as rising living standards and a growing awareness among citizens around the world to live in an environmentally friendly environment have resulted in an increase in demand for floriculture products in both developed and developing countries. The Indian government has designated floriculture as a sunrise sector with a 100% export-oriented status. Owing to a steady increase in demand for flowers, floriculture has become one of the important commercial trades in agriculture (APEDA).

In 2008-09, India's floriculture area was estimated to be over 1,67,000 hectares, with over 987 million tons of loose flowers and 4,794 million cut flowers produced (Anonymous 2009). The area under floriculture in Maharashtra is 16,740 hectares, with a production of 69.45 thousand tonsof flower products (Anonymous 2009). In the year 2008-09, India's total floriculture exports totaled 368.81 crores (Anonymous 2008-09). Metropolitan cities such as Mumbai, Kolkata, Chennai, Bangalore, Delhi, Pune, Mumbai, Nashik, Ahmednagar, Sangli, Kolhapur, Thane, Satara, and Nagpur are prominent flower marketing centers. Flowers such as chrysanthemum, gladiolus, rose, tuberose, gerbera, carnations, marigold, asters, anthurium, orchids, jasmine, and others are grown, with annual demand for flowers increasing by more than 25%.

Globally, the export of flowers has increased phenomenally from 8 billion US dollars in 2006 to 13 billion US dollars in 2015. The number of countries reported to have exported flowers in 2006 was 50, which has increased to 118 in the year 2015. The Compound Annual Growth Rate (CAGR) of the world's flower exports during 2006–2015 was 5 percent. In 2016-17, India exported 22,086 MT of flowers to the rest of the world, worth 549 crores. India is in the 18th place, contributing 0.6% of the global floriculture trade. During the last decade, exports increased at a CAGR of 4.33 percent. In India as a whole, the domestic Indian market is growing at a rate of 25% per year. In recent years, states such as Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal, Maharashtra, Rajasthan, Delhi, and Haryana have emerged as major floriculture centers. (Vahoniya *et al.*, 2018).

Floriculture, thus, provides great opportunities to farmers for money generation and empowerment. The farmers can grow flowers and foliage crops on every inch of their land. Floriculture also offers careers in

production, marketing, export, and research. One can find employment in the floriculture industry as a farm manager, plantation expert, supervisor, or project coordinator, and many more positions. Besides, one can work as a consultant or landscape architect with proper training. In addition, floriculture provides opportunities in the service sector, which include such jobs as floral designers, landscape designers, and landscape architects

.2. Introduction on Dry flowers

Flowers are magnificent creations of nature considered as an image of adoration, excellence, and a worldview of life in view of their innumerable tones. Fresh flowers, no matter how beautiful they are, are expensive, fleeting, temperature sensitive, and only available during a specific season (Shailza *et al.,* 2018). Their freshness and excellence is lost because of different biochemical changes and microbial activities, and they can be retained only for few days, even by utilizing the best methods of postharvest technology (Datta 1999). Even when the best flower additives or chemicals were used, the shelf life of flowers could only be extended by 40% (Ranjan *et al*., 2002). To conquer this problem, the same flowers and foliage's can be dried to prolong their beauty and freshness, which holds both economic and aesthetic importance (Saima *et al.,* 2020). Dehydration of flowers is the practice of preservation of flowers or the process of abolishing the moisture from flowers. The drying techniques result in the preservation of flowers and foliage, and the products can be successfully utilized in the preparation of various floral decorations and different craft items (Saima *et al.,* 2019). Dried flowers have a long life and can be used multiple times to meet decorative needs. Dried flowers offer an excellent opportunity to Indian entrepreneurs because the country has a wide variety of floral materials, cheap labor, and a favorable climate (Gurumurti 1997). Dry flowers and foliage are attractive and possess a number of abilities, including ornamental, durable, lifelong, and year-round availability (Joyce 1998). The dried flowers and plant parts are natural, inexpensive, and have everlasting value with year-round availability (Safeena *et al.,* 2006). Thus, dried flowers come as a brilliant option in contrast to fresh flowers and foliage for interior design as well as for a variety of other aesthetic and commercial uses.

The majority of people choose dried flowers as they require little care and are much more durable. The dried floral arrangement can be kept anywhere with no worries of water spills or having to change the soil or even prune the leaves. Dry flowers are natural flowers processed and preserved in a manner to retain their qualities for a prolonged duration. The interest in dried flowers comes in waves, bringing all the old applications and techniques along with fresh ideas and inspiration.

The most beneficial zone of floriculture is the dry flower industry. This industry has developed quickly, with more than 60% of benefits belonging to the floriculture business (Ranjan *et al.,* 2002). The business's extended yearly turnover starting in 2003 was in excess of 150 crores (Singh 2009). Potpourris are a significant portion of the dry flower industry, esteemed at Rs. 55 crores in India alone (Murgan *et al.,* 2007). The business in India is over 40 years old and exports 500 varieties of flowers to 20 nations (Bhattacharjee *et al.,* 2003). The USA is the biggest consumer of dried and artificial flowers, assessed at US $2.4 million yearly, followed by Germany and the UK (Bhattacharjee *et al.,* 2003).

With its rich floral diversity, India could serve as a major raw material supplier for the industry. To encourage the eco-friendly trade, the government has given a rebate of 25% on the freight of this product, and a bulk quantity of the raw material is exported from India to developed countries like the UK, Japan, and America, where dried flower arrangements are in great demand (Puri 1995). Besides domestic consumption, there is an increasing demand worldwide for the decoration of living and working places with eco-friendly items.

With the growing demand for natural, eco-friendly products, dried flowers and dried botanicals have seen significant growth in the floriculture industry. Future possibilities of dry flower industry are relied upon to contribute a tone to the country's economy in contrast to fresh cut flowers and other live plants. Exports of floriculture from India increased by 2.66 percent in recent years, rising from Rs. 266 crores in 2002–2003 to Rs. 302 crores in 2003–2004 and Rs. 273 crores in 2004–2005. Dry flowers account for 71% of India's export basket, which is exported to the United States, Europe, Japan, Australia, and Russia. Dry flowers account for about two-thirds of all floriculture exports. The demand for dried flowers is growing, providing Indian entrepreneurs with numerous opportunities to enter into the global floricultural trade (Singh 2009).

Dry flowers can be formed by simple drying techniques in which, along with reduction of water content, the color and shape of flowers are retained to a maximum extent so as to preserve their beauty and hence their value. Dry flowers, thus, obtained can be preferably used in comparison to acrylic and plastic flowers so as to sustain the environment by avoiding pollution. The various methods used for the drying of plant materials include air drying, press drying, embedded drying in desiccants, microwave oven drying, hot air oven drying, water drying, glycerin drying, skeletonization, etc. Air drying is the easiest natural method for the preservation of flowers and foliage. Pressing is the

oldest method, having its first report in 1820, which was then used by the botanist for the preparation of herbarium, which also became part and parcel of the syllabus for studying Botany. Flowers with heavy moisture content are subjected to dehydration by exposure to desiccants in which water content is totally absorbed by desiccants such as sand, borax, and silica gel. Many workers have already recommended this method for delicate flowers, which are not generally preserved by other methods. Flower drying in a microwave or hot air oven is the fastest method that yields colorful and better quality dry flower products. Water drying is good for the drying of certain flowers. Glycerin drying brings the leaves into an everlasting category. Skeletonization reduces the leaf to a network of veins and so on. Whatever the method used, it should aim at the retention of shape, color, and, moreover, the overall beauty of flowers as such.

3. Advantages of dry flowers: Dried flowers are predominantly utilized in beautification, especially for floral arrangements. They can be organized in different ways to invigorate the interior decoration of homes and other functions throughout the year. Dry flowers and products are popular because of the number of advantages they have.

- Dry flowers are both environmentally friendly and cost-effective. As a result, they can be reused multiple times.
- Dry flowers can withstand a wide range of temperatures. It can withstand the scorching heat of summer and the freezing cold of winter.
- Dry flowers require less care and maintenance and are available throughout the year.
- Dry flowers are useful in every season, especially during winters when fresh flower availability is limited and expensive.
- Dry flowers can be transported easily with fewer transportation charges than fresh flowers.
- Dry flower arrangements can last indefinitely if the flowers and foliage are dried and preserved with suitable methods of drying and preservation. The art of crafting and composing captivating dried flower arrangements is limitless.
- Dry flowers and products can be used in generating of diverse, economically useful products. Hence, it can be used in revenue generation throughout the year.

4. Precautionary measures for selecting the plant material for drying

The selection of a suitable crop is the primary requirement to get better quality products. The plant material selected for the process of drying and preservation can be collected throughout the year. Almost all plant material, everything from flowers, foliage, branches, seed pods, cones, tree branches, etc., can be successfully dried with different drying methods. The following important measures should be taken while collecting the plant material to get the desired results:

- The flowers, foliage, and leaves should be healthy. The plant material should be cut with the help of a clean and sharp cutter.
- The flowers at different stages of development and the foliage at the peak of its growing season should be collected.
- Flowers with bright colours should always be preferred.
- The plant material to be dried should be cleaned properly and wiped off of any moisture.
- Extra bunches of plant material should be collected to allow for some loss. The selected plant material should be processed for drying soon after cutting to prevent it wilting.
- We must be continually careful in cutting the plant material and have to never cut the endangered plants.

4.1 Stage of harvest

The appropriate stage of harvesting the plant material for drying is important to get the best results. The proper phase of flowers to be reaped is the point at which they have just started to develop or at a completely open stage. However, it varies as per the species and the form of flower desired. Fresh plant material should be gathered for drying, while blurred and old ones should be discarded. The flowers of different plants can be assembled at various stages (Paul and Shylla 2002), but they should be collected only as they come to maturity (Padmavathamma 1999). Flowers could be collected either at the bud stage or at later stages until their colour has not blurred. The delay in harvesting time (2–3 days) brings about the collapse of petals, which causes their shattering (Bhattacharjee *et al.,* 2003). According to Safeena *et al.,* (2006), rose flowers harvested at half bloom stage provide superior quality dry roses with less drying time and better colour retention due to colour stability at this stage. Datta (1997) recommended that flowers and foliage should be gathered from the fields a couple of days after irrigation. The gathered material should be liberated from surface dampness and dew. Subsequently, it is better to gather the material in the dry season on a bright day. White *et al.* (2002) reported that materials like dry grasses, seeds, pinecones, and most seed heads should be reaped in their full maturity

stage toward the finish of their developing season before they become wilted.

5. Significance of moisture in dried flowers

The moisture content has a significant impact on the form of the flowers. The less moisture provides rigidity in flowers and results in uniform cell contraction, while the higher moisture in dried flowers leads to flaccid flowers. Chen *et al.,* (2000) reported that the lower moisture content results in stiffer and harder petals in dried flowers. The mechanical support provided by the media throughout the drying process ensures that the flower shape is maintained as long as the moisture content is less than 11.55 percent. Furthermore, the moisture content of dried flowers has an impact on longevity and is inversely proportionate to it (Pandey 2001). To keep their quality and firmness for more than six months, dried flowers must have a moisture content of 8–11.5%. Excessive flower drying resulted in petal shedding during handling (Singh 2004). Drying below 8% moisture content leads to the shedding effect, which is related to excessive moisture loss. This could lead to decreased adhesion and cohesion forces in flower tissue, as well as softening of the middle lamella, leading to abscission.

6. Methods of drying

Drying of flowers is a method of preservation of flowers or the process of disposing of moisture from the flowers. Dry flowers, form ages, have been the fundamental part of every household décor. Dry flowers are dehydrated botanicals and flowers. Anything from flowers to foliage, petals, buds, stems, roots, twigs, branches, cones, leaves, ferns, mosses, etc. in a dried form comes under the domain of dry flowers and can be used in natural, dyed, bleached or preserved forms. The quality and appearance of dried flowers is greatly influenced by the method of drying. There are a number of drying methods by which dehydration of flowers and other botanicals can be done. Some of the most commonly used methods are Air drying, Press drying. Embedded Drying in Desiccants, Microwave Oven Drying, Hot Air Oven Drying, Glycerin Drying, Water Drying, Skeletonization. The variety of flowers and foliage are well dried and respond very well to certain drying methods. Some plant materials, on the other hand, are naturally dry and require little effort to preserve.

Naturally dry plant materials

Naturally dry materials include dry grasses, seeds, pine cones, and most seed pods. This material should be harvested when in good condition, usually in the fall at the end of its growing season, but before it becomes weathered in appearance. The selected plant materials can be bleached, then dyed or painted to give them a more beautiful and decorative look and can be used as an addition in different flower arrangements.

6.1 Air drying

Air drying is the easiest and most affordable strategy for drying. It is also known as the "Upside Down" or "Hang and Dry" method of drying (Verma *et al.*, 2012). In this method, the plant material is appended to rope or wire and is kept in a hanging position as illustrated in fig.1a. Flowers can likewise be spread over blotting sheets or newspapers and can be kept in the dark or in the sun. Flowers of good quality should be selected at an immature stage, peeled off the foliage, and hung upside down in a warm dark area with good air circulation. Flowers take 1-2 weeks to dry, depending entirely on moisture content, temperature, and humidity (Kumar *et al.*, 1998). Large flower heads should be hung individually. Most of the flowers can be dried on their own stems. However, some flowers, such as the strawflower, have weak stems and need a wire to be inserted before drying to support the flower. Flowers should be kept in the same position and without touch for the next 1-2 weeks for absolute drying. Brown *et al.* (2013) reported the fleshier the flowers or foliage, the more time it will take to dry. The stage of harvest is also important for getting a superior quality of dry flower in this method. Strawflower, Globe amaranth, Salvia, Chrysanthemum, and other flowers should be picked at the bud stage or partially opened because they continue to open while drying (Smith 1993). Susan (1990) reported that flowers with a crisp texture, like straw flowers, statice, and so forth, are suitable for this method of drying. This technique is basic and modest. Yet, the drying period is longer, and such flowers normally hold straight stems after drying. Bryan (1992) found air drying as the easiest technique to dry roses, statice, straw flowers, etc. There are a number of flowers that can be successfully dried by this method. However, some of the flowers lose their colour in this process and become dark and stiff (Saima *et al.*, 2020). Plant materials suitable for air drying with an approximate drying time areenlisted in Table-1

Flow chart for Air drying

Harvestgood quality flowers at slightly immature stage

↓

Stripe off the foliage from the lower part of the stem

↓

Tie the selected floral material with rope or with wire

↓

Hang upside down in a clean, dark and well ventilated area

↓

Keep it in a same position and without touch for next 1-2 weeks for absolute drying

Table-1 Plant material suitable for Air drying with approximate drying time

Plant material	Family	Approx drying time(days)
Tagetes erecta	Asteraceae.	8-9
Rosa indica	Rosaceae	10-11
Gerbera jamesonii	Asteraceae	10-12
Gladiolus dalenii	Iridaceae	9-10
Dianthus caryophyllus	Caryophyllaceae	9-10
Xerochrysum bracteatum	Asteraceae	6-8
Cosmos peduncles	Asteraceae	7-8
Setaria italica	Poaceae	7-8
Salvia splendens	Lamiaceae	7-8
Solidago canadensis	Asteraceae.	7-8
Hydrangea macrophylla	Hydrangeaceae,	8-9
Xerochrysum bracteatum	Asteraceae	7-8
Thuja occidentalis	Cupressaceae	6-7
Gomphrena globosa	Amaranthaceae	7-8
Amaranthus caudatus	Amaranthaceae	6-7
Centaure acyanus	Amaranthaceae	7-8
Limonium latifolium	Plumbaginaceae	7-8
Limonium sinatum	Plumbaginaceae	6-7
Papaver somaniferum	Papaveraceae	6-7
Salvia splendens	Lamiaceae	7-8
Helianthus annuus	Asteraceae	7-8
Chrysanthemum grandiflorum	Asteraceae	6-7
Solidago canadensis	Asteraceae	7-8
Acroclinum roseum	Asteraceae	8-9
Lilium dalhansonii	Liliaceae	7-8

6.2 Pressdrying

Press drying is one of the most established techniques utilised and is accepted to have been first reported in 1820. Later on, it was utilised by botanists or herbalists for the preparation of herbariums (Lawrence 1969). Pressed and dried plant specimens are useful as teaching aids, reference sources for plant identification, or as decorative material. Press drying is the most common method for the preservation of flowers and foliage. Press drying involves placing plant material between the folds of absorbent paper and applying appropriate pressure until the material is dried. Exaggerated imbrications of plant parts and unnecessarily folded leaves should be avoided. The pressure can be applied in various ways, such as with the help of a plant press (Fig.1a). The Plant Press is an equipment which is particularly designed for botanists to flatten the plant samples. It is composed of two strong boards, the outer and inner board, provided with straps or screws that can be tightened around them to exert pressure. Aside from this, press drying can be achieved by keeping the blotting paper containing plant material in between the heavy books. The duration required by the plant material to dry by press drying varies with the type of plant material and the water content of the tissue, but it should be completed within four weeks (Sell 1993). Even so, the drying time can be reduced if the sheets are kept in the oven at an appropriate temperature (Datta 1997). Anonymous (2001) reported that most flowers and leaves are suitable for pressing except those with bulky centres, such as succulents and odd-shaped flowers such as daffodils. In that case, it needs to be cut in half and opened out before pressing. Prasad *et al.* (1997) reported that the shape of plant material cannot be maintained as it becomes flattened because the fresh material, after pressing within the iron or wooden frame, tends to stick to the paper. The flattened floral material obtained from pressing can be utilised in the preparation of various value-added products (Saima *et al*.,2020). However, most flowers and foliage dried by this method retain maximum colour (Saima 2021). Plant materials suitable for press drying with an approximate drying time areenlisted in Table-2.

Table-2 Plant material suitable for Press drying with approximate drying time

Plant material	Family	Approx. drying time(days)
Canscora diffusa	Gentianaceae	7-8
Leucas stelligera	Lamiaceae.	7-8
Gnidia glauca	Thymelaeaceae	9-10
Bougainvillea glabra	Nyctaginaceae	5-6
Calliandra haematocephala	Fabaceae.	9-10
Pentas lanceolata	Rubiaceae.	7-8
Ixora coccinea	Rubiaceae.	7-8
Lantana camera	Verbenaceae.	6-7
Stachyotarpeta jamaicensis	Verbenaceae.	6-7
Adiantum pedatum	Pteridaceae.	8-10
Cesalpinia pulcherrima	Fabaceae	7-8
Plumeria rubra	Apocynaceae	6-7
Hibiscus rosasinesnsis	Malvaceae	6-7
Ranunculus acris	Ranunculaceae	6-7
Pogostemon benghalensis	Lamiaceae	7-8
Gypsopilia elegans	Caryophyllaceae	8-9
Ipomoea quamoclit	Convolvulaceae	6-7
Impatiens balsamina	Balsaminaceae	6-7
Jaquemontia pentantha	Convolvulaceae	7-8
Eranthemum roseum	Acanthaceae	8-9
Gloriosa superba	Lilaceae	7-8
Matricaria chamomilla	Asteraceae	8-9
Peltophorum pterocarpum	Fabaceae	7-8
Belli sperennis	Asteraceae	6-7
Delphinium ajacis	Ranunculaceae	7-8
Dendranthema grandiflora	Asteraceae	6-7
Limonium sinuatum	Plumbaginaceae	7-8
Viola tricolor	Violaceae	7-8
Iberis umbellata	Brassicaceae	6-7
Clerodendron thomsonae	Verbenaceae	7-8

Flow chart for Press drying

Select and collect the bright colored flowers & foliage's

↓

Place the selected plant material in between the folds of an absorbent paper/ news paper

↓

Keep the selected material under press/plant press/heavy books

↓

Likewise make 4-5 rows of absorbent paper containing plant material

↓

Cover the plant press and fasten the screws

↓

Keep the press at room temperature

↓

Change the blotting paper sheets kept in between the plant materialon every alternate dayto avoid fungal attack.

6.3 Embedded Drying in desiccants

Embedded drying is one of the best methods of flower drying, especially for flowers with a delicate texture and high moisture content that break or deform when air dried. Susan (1990) reported that this method is beneficial for delivering flawless life to flowers in both form and color. The commonly used desiccants are sand, borax, and silica gel. As reported by Westland

(1992), borax showed slight blurring of color and a harsh petal surface. For delicate flowers like roses, dahlias, carnations, etc., silica gel is the ideal drying agent. Christy (1999) proposed that silica gel has significantly extended the varieties of flowers to be dried. Silica gel is light in weight, streams effectively and makes it simple to encompass all the parts of the flowers for quick drying. It requires 5-10 days to dry, and flowers not suitable for air drying can be well dried with this method. Singh *et al.* (2003), while testing various media such as sand, borax and silica gel, concluded that maximum moisture loss was observed when the flowers were embedded in silica gel. Gupta *et al.* (2005) reported that among four desiccants (viz., boric corrosive, silica gel, stream sand, and saw dust), silica gel has been discovered to be the best desiccant for eliminating moisture from flowersandfoliage. The flowers dried in silica gel are less deformed and retain their maximum shape and color. Saima *et al.*, (2020); Saima *et al.*, (2021a). In theembedded drying method, the desiccant is adequately spread at the bottom of the container, the selected flowers are carefully placed according to their shape in the proper position, and the container is then covered again with a sufficient quantity of desiccant, so that all the flower heads get properly embedded in desiccant. Containers thus prepared must be kept in a well ventilated area and should be observed periodically. Embedding in deep containers can accommodate the plant material without disturbing the shape and form of plant materials like chrysanthemum, candytuft, bougainvillea, dahlia, gerbera, marigold, and roses, etc. (Bhutani, 1990). The plant materials suitable for embedded drying with an approximate drying time are enlisted in Table-3.

6.3.1 Sand as desiccant

Sand drying is one of the oldest and least expensive methods for the drying of flowers. The sand as a desiccant for flowers must be fine, clean, dry, and preferably salt-free. In this method, a sufficient quantity of sand (about an inch or two) is poured in a container or in a box**,** the material of interest is placed according to its shape, and the sand is sprinkled around each petal very carefully without disturbing the position and shape of flowers, as shown in fig.1a. Containers, thus prepared, must be kept for drying in a warm and well ventilated area for 1-2 weeks.

6.3.2 Borax as desiccant

Borax as a desiccant can be employed in the dehydration of flowers and can also be used in combination with sand and cornmeal to get better results. In this method, borax is poured at the bottom of the container and the selected flowers are placed according to their shape in the proper position as shown in fig.1a, and are then again covered with a sufficient quantity of borax so that all flower heads get embedded properly in the borax material in the container. Containers thus prepared must be kept for drying in a well ventilated area for 1-2 weeks.

6.3.3 Silica gel as desiccant

Although silica gel is an expensive desiccant, it can be reused (crystals of silica gel can be dried properly in an oven at 100-125oC temperature to be reused many times). In this method, silica gel is poured in a container with a tight lid, the selected flowers are placed in it as shown in fig.1a and are then covered to embed in excess silica gel. The containers thus prepared are kept in a well ventilated area for drying for 5–10 days.

Flow chart of desiccant drying

Take a container and spread the layer of a desiccant on its bottom

↓

Place the flowers in it without disturbing their shape

↓

Cover the flower heads gently with desiccant

↓

Keep the container in a well ventilated area for drying

↓

After drying remove the excess remaining desiccant from flowers gently with a small brush

6.4 Microwave oven drying

Microwave oven drying works by producing an electronic microwave that releases the moisture from organic substances by agitating the water molecule. It is a quick strategy, and the product quality is better in terms of colour and shape maintenance. Microwave oven drying is not appropriate for all flowers. It is best for flowers with numerous petals, like marigolds, roses, carnations, and zinnia. Thomler (1997) reported that flowers with bunches of florets, such as goldenrod, gypsophilla, and corn flower, etc., are more appropriate for microwave drying, while flowers with flimsy, fragile petals or those with hairy and sticky surfaces are not very suitable for drying in the microwave. For example, flowers with thick petals or high water content, for instance, Magnolia, hyacinth, and orchids, don't dry well in the microwave. In this method, the flowers are placed in a microwave-safe compartment as illustrated in fig.1a. Set a little cup of water in the microwave prior to cooking to avoid over-drying.

Drying time differs as per the size and moisture content of the flower. However, plants are typically dried in 2–5 minutes and the material is kept at room temperature (for 4-5 hours as setting time, which varies from plant to plant). Plant materials suitable for microwave oven drying are enlisted in Table-4.

Table 3 Plant material suitable for Embedded drying in silica gel with approximate drying time

Plant material	Family	Approx drying time(days)
Amaranthus caudatus	Amaranthaceae	5-6
Alcea rosea	Malvaceae	5-6
Aster amellus	Asteraceae	5-6
Camellia japonica	Theaceae	5-6
Impatiens balsamina	Balsaminaceae	5-6
Ranunculus acris	Ranunculaceae	5-6
Dianthus caryophyllus	Caryophyllaceae	5-6
Gladiolus dalenii	Iridaceae	5-6
Gerbera jamesonii	Asteraceae	6-7
Tagetes erecta	Asteraceae	6-7
Tagetes patula	Asteraceae	6-7
Rosa indica	Rosaceae.	6-7
Helianthus annuus	Asteraceae	7-8
Strelitzia reginae	Strelitziaceae	6-7
Celosia cristata	Amaranthaceae	3-4
Dendranthema grandiflora	Asteraceae	6-7
Lagerstroemia speciosa	Lythraceae	7-8
Echinacea angustifolia	Asteraceae	6-7
Hemerocallis fulva	Asphodelaceae	6-7
Zinnia angustifolia	Asteraceae	5-6
Lavendula bipinnata	Lamiaceae	6-7
Antirrhinum majus	Plantaginaceae	7-8
Dahlia pinnata	Asteraceae	5-6
Centaure acyanus	Asteraceae	6-7

Table-4 Plant material suitable for Microwave oven drying

Plant material	Family	Temp & Heating time
Aster ericoides	Asteraceae	At 45ºC for 4-5min
Calendula officinalis	Asteraceae	At 45ºC for 4-5min
Dahlia variabillis	Asteraceae	At 45ºC for 5-6min
Dendranthema grandiflora	Asteraceae	At 45ºC for 4-5min
Rosa indica	Rosaceae	At 50ºC for 6-7min
Callistephus chinensis	Asteraceae	At 45ºC for 3-4min
Dendrobium noblie	Orchidaceae	At 50ºC for 2-3min
Gladiolus dalenii	Iridaceae	At 45ºC for 5-6min
Gerbera jamesonii	Asteraceae	At 50ºC for 6-7min
Helichrysum bracteatum	Asteraceae	At 45ºC for 3-4min
Callistphus chinensis	Asteraceae	At 45ºC for 3-4min
Ixora chinensis	Rubiaceae	At 45ºC for 3-4min
Clerodendron thomsonae	Lamiaceae	At 45ºC for 2-3min
Helipterum roseum	Asteraceae	At 50ºC for 2-3min
Zinnia elegans	Asteraceae	At 45ºC for 4-5min
Delonix regia	Fabaceae	At 45ºC for 4-5min

Flow chart of Microwave oven drying

Set a little cup of water in the microwave prior to cooking to avoid over drying of flowers

↓

Place the flowers in the microwave safe compartment at 40-45oC for a specified period of time

↓ ↓

Takeout the flowers and keep themat room temperature for 4-5 hours as setting time

6.5 Hot air oven drying

In this method, the plant material is kept at controlled temperature conditions (Bhattacharjee *et al.*, 2003). The flowers are slotted through holes in a wire mesh rack in the oven and are kept at a controlled temperature for a specified period of time, as illustrated in fig.1a. Time and temperature combinations vary from plant to plant and mainly depend upon the compactness and thickness of flowers. Temperature plays a significant part in the drying of flowers and other plant parts by influencing both qualitative and quantitative parameters. At higher temperatures, the rate of transpiration is comparatively much higher. With the increase in temperature, the diffusion pressure deficit of air increases, which stimulates diffusion of internal moisture surface and further increases its vaporisation rate, thus leading to high moisture loss at higher temperatures (Mayak and Halevy 1980). Half opened flowers or flowers at bud stage are suitable for drying in a hot air oven, while completely opened flowers are not appropriate as their petals free versatility and strip off effectively on drying (Verma *et al.,* 2012). Kher and Bhutani (1979) reported that the 35-39oC temperature was ideal for Bougainvillea (48 hours), Pompon Dahlias and Narcissus (72 hours). The temperature of 40-44°C was found ideal for *Aerva javanica*, *Euphorbia leucocephala*, *Delphinium ajacis*, and *Mina lobata*. This method yields superior quality products with the retention of both shape and colour, excluding white coloured flowers, in a shorter time. Saima *et al.*, (2020); Saima *et al.*, (2021b). Plant materials suitable for hot air oven drying are enlisted in Table-5.

Flow chart of Hot air oven drying

Place the flowers through the slotted holes in a wire mesh rack of the oven

↓

Set the required temperature of the oven for the drying of selected flowers

↓

Keep the flowers in the same position for a specified period of time

↓

Take out the flowers and keep them at room temperature for sometime

Table-5 Plant material suitable for Hot air oven drying

Plant material	Family	Temp & Drying time
Antirrhinum majus	Plantaginaceae	12(hrs) at 50oC
Anthurium andraeanum	Araceae	10 (hrs) at 45oC
Amaranthus caudatus	Amaranthaceae	10(hrs) at 45oC
Callistephus chinensis	Asteraceae	9(hrs) at 50oC
Dahlia variabilis	Asteraceae	11(hrs) at 45oC
Dianthus caryophyllus	Caryophyllaceae	11 (hrs) at 45oC
Dendrobium sp	Orchidaceae	10 (hrs) at 45oC
Digitalis lanata	Plantaginaceae	9(hrs) at 50oC
Dendranthema grandiflora	Asteraceae	9(hrs) at 50oC
Zinnia angustifolia	Asteraceae	10 (hrs) at 45oC
Zinnia elegans	Asteraceae	10 (hrs) at 45oC
Helianthus annuus	Asteraceae	12(hrs) at 45oC
Narcissus poeticus	Amaryllidaceae	10 (hrs) at 50oC
Ixora coccinea	Rubiaceae	9(hrs) at 50oC
Gomphrena globosa	Amaranthaceae	10 (hrs) at 45oC
Helipterum roseum	Asteraceae	11(hrs) at 45oC
Lilium dalhansonii	Liliaceae	12 (hrs) at 45oC
Gerbera jamesonii	Asteraceae	12 (hrs) at 50oC
Rosa sp	Rosaceae	13-14 (hrs) at 45oC
Tagetes sp	Asteraceae	10-12 (hrs) at 45oC

6.6 Water drying

There are some flowers that dry well in water by the process of evaporation (Sushil Kumar *et al.*, 2021). In this method, the stems of the flowers are first positioned in water at a few inches deep where water is taken up by the fresh flowers to keep the petals intact, as illustrated in fig.1a. The container and flowers should be kept in a dry, warm, and dark area for 6–10 days to dry normally. Anonymous (2001) suggested that Hydrangea, Gypsophila, and *Alchemilla mollis* should be picked and set in an upright position in a jar with an inch of water in the base. When the flowers have utilised all the water, they have dried effectively. Plant materials suitable for water drying are *Hydrangea macrophylla*, *Centaurea cyanus*, *Gypsophila sp.*, *Celosia argentea*, and *Moluccella laevis.*

6.7 Glycerin drying

Glycerin is reported as one of the best osmotic reagents, effective for drying while maintaining flexibility, form, and texture. As a result, preserved plant material is less brittle than dried plant material, making it less susceptible to shattering and mechanical damage (White 2007). Several workers have employed glycerin drying to preserve leaves for longer periods of time, as it is comparatively least expensive and has a good water holding capacity (Joyce 1998). Several types of foliage have been successfully preserved by immersing leaves or crushed stems in a 33 percent glycerol solution. The resultant leaves are smooth and flexible (Dana 1983). Westland (1995) reported that preserving foliage and berries in glycerin and hot water solutions introduced them into a nearly everlasting category. Freshly cut statice stems may be preserved by soaking in a 1:2 or 1:3 glycerol water solution for 48 hours followed by microwave drying for 1 min at a medium high temperature (34oC) as same reported by Dubois (2005). A solution of 10–30% glycerol in water was found to be satisfactory for preserving most of the foliage. In glycerin drying, the quality of the product was good as moisture in the flower was replaced by a mixture of water and glycerin (Paul and Shylla 2002). Although this process is generally applicable for foliage. However, certain flowers like ringers of Ireland, statice, hydrangeas, woman's mantle, narcissus, and rose hips can also be dried (Anonymous 2001). Dana *et al.* (2002) detailed glycerinisation asbest methodfor preserving small leaf tree branches where glycerine enters the leaves and turns dark. The typical drying period is 2-3 weeks. In this method, one part of glycerin is mixed with two parts of warm water (Semant *et al.*, 1993), and the appropriate plant material is kept in a glycerol water solution at a depth of 5 cm, as illustrated in fig.1a. It takes 1-3 weeks for complete drying, depending upon the plant material. Glycerin serves as a good source for microorganisms, so a pinch of antibiotic is necessary to prevent microbial growth in the dried specimens. Plant material (leaves) suitable for glycerin drying are *Ocimum gratissimum, Melia azedarach, Morus alba, Ficus benjamina, Ficus benghalensis, Ficus nuda,Magnolia spp, Eucalyptus globules, Lagerstroemia speciosa, Aspidistra elatior, Sorbus domestica*, *Fatsia japonica, Grevillea robusta, Digitalis purpurea, Camellia japonica*, *Catharanthus sp*, etc.

6.8Skeletonization

It is well-known that people utilize diverse plant materials for aesthetic purposes by different methods. The leaf venations that have been reduced to their system of veins can be made to preserve the unceasing attractiveness of leaves in which both the qualities of nature’s creation and the enthrall of craftiness can be enjoyed. Fantabulous images of leaf veins can be acquired from leaves from which the soft tissue is excluded. This procedure removes all green pulp but keeps the veins of the leaf intact, as shown in fig.1a. Leaf venation preparation is an art which can be used for beautification and for interior decoration. The venation pattern of plant leaves offers a great beauty. This results from the visual combination of their complexity and regularity.

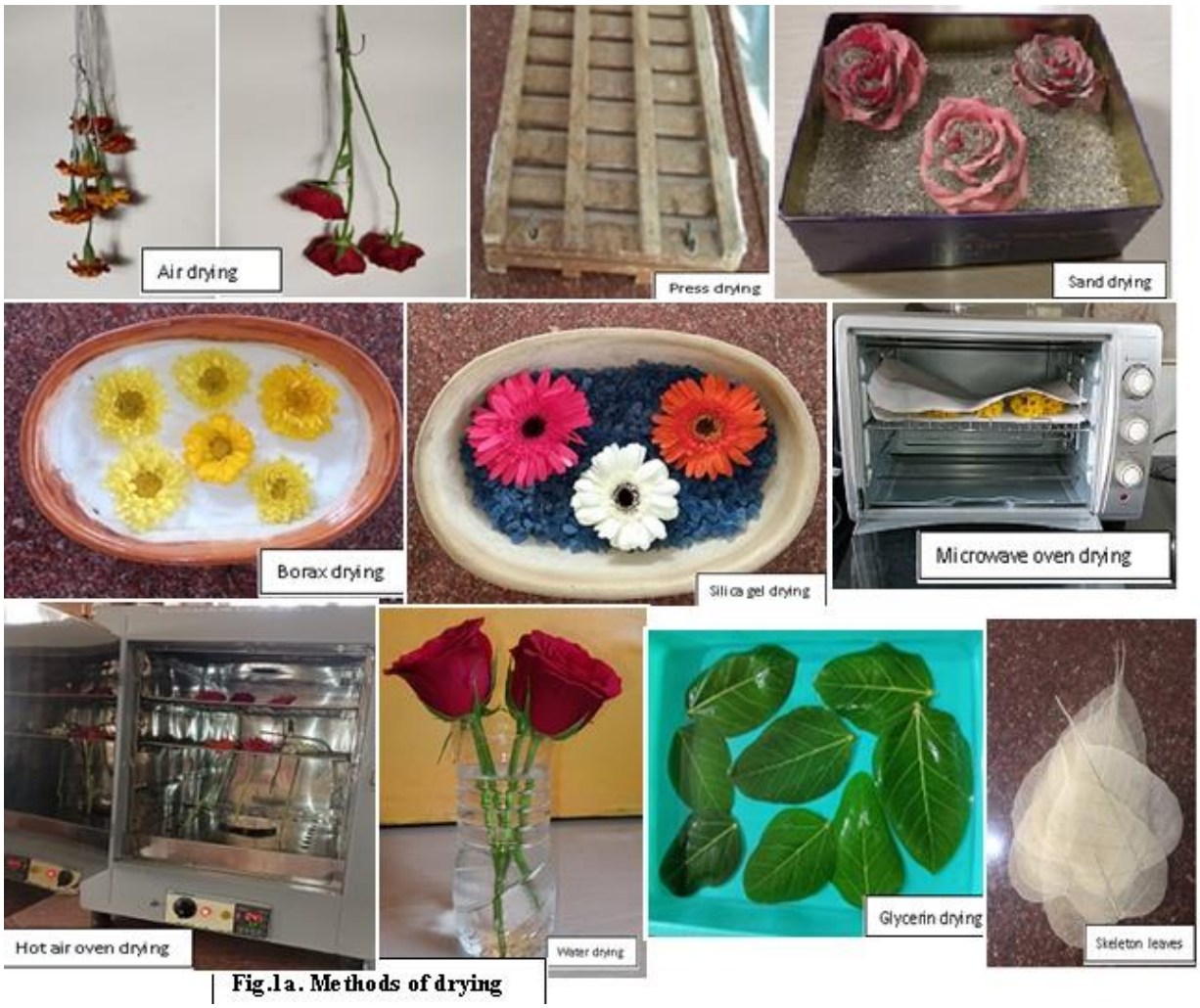


Fig.1a. Methods of drying

Even though the variations in morphology have some common features, the leaf venation of dicotyledonous plants usually forms a complex pattern. The veins form developed structures which are connected to form a reticulum. A skeletonized leaf shows high resistance, is flexible, and does not crumble easily. Due to their durability, they can be used in fashion and fine arts, applied to packaging, lining, lighting fixtures, furniture, canvas, glass, fine stationary, shop windows and wherever else your imagination will take you. They can also be turned and twisted into beautiful handcrafted flowers (Saima 2020). Unlike dry or dehydrated leaves, the skeleton leaves show high resistance. The skeletonization of leaves is a natural process, but it takes a long time to expose the inner mantle of leaves. The naturally processed skeleton leaves have a deteriorated network of veins. Hence, it cannot be used further in any application because of the damaged structure of venations (Saima *et al.*, 2019). In this procedure, leaves are boiled for 40 minutes in a solution of 1 teaspoonful of baking soda or lye per quart of water and are then rinsed with cold water. The tissue between the veins is removed cautiously with the help of a soft brush. The leaf skeletons thus obtained can be dyed with vibrant colors and can be used for the preparation of different value-added artefacts (Saima 2020). Plant materiasl suitable for the process of skeletonization are heavily textured and matured leaves (Saima *et al.*, 2013).

7 Bleaching

Dry flowers and skeletonized leaves are characteri sed by discoloration due to yellowing or some other undesirable color. To lighten discoloration, plant material can be bleached using oxidative and reductive bleaching agents or can be sulfured. As oxidative bleaches such as chlorites, hypochlorites, and peroxides or peroxy compounds break down colored compounds, adding reductive bleaches such as borohydrides and sodium sulphide tends to convert them into colorless compounds. The chemical property of sodium chlorite makes it an excellent bleaching agent, as it selectively binds to lignin without damaging the fiber. Among reductive bleaches, zinc or sodium hydrosulfite is leastexpensive and offer the strongest bleaching power. The bleached plant material can be immediately incorporated into a variety of floral arrangements or can be dyed with different colors. Bleaching allows the usage of dyes for the coloring of plant material. The plant material leads to choppy shades when dyed without bleaching. Sulfuring is also done to prevent enzymatic discoloration. Sulfur dioxide acts as a bleaching agent for colored plant material and, when used at a particular concentration, can help in the fixing of colors in a few flowers also (Suhrita *et al.,* 2021). Acidification of the tissues leads to the fixation of color. Sulfuring is produced by burning sublimed sulphur powder or by injecting sulphur dioxide gas (1–3%) right into a sealed chamber. Prior to ventilation of the chamber and subsequent completion of the drying system, plant materials are typically treated with sulfur dioxide overnight (Verma *et al.,* 2012). In addition to bleaching with oxidative or reductive chemical compounds, the plant material may exhibit yellowing. In order to prevent yellowing, the multistep bleaching method is alternated with reductive bleach. A final rinse with a 2% solution of barium hydroxide, calcium hydroxide, sodium bicarbonate, or aluminium sulphate may also help to prevent yellowing (*Suhrita et al.,* 2021).

For bleaching dried plants of rose, chrysanthemum, and celosia, 10–30% of sodium chloride is an appropriate concentration. Sodium hypochlorite was also found suitable for bleaching French marigold and multicolored zinnia. Dried pods of *Acacia auriculiformis, Sesamum indicum, Gossypium hirsutum*, and *Pongamia glabra*, cones of Pinus spp. showed the lowest bleaching time of 6 hours and minimal damage with maximum whiteness index and shape retention when treated with 20% sodium chlorite+5% hydrochloric acid (Datta *et al.,*2021). Sujatha *et al.,* (2001) found hydrogen peroxide to be an excellent bleaching agent at room temperature as it caused the least damage to cellular tissues and thus was perfect for bleaching. Marak and Chakrabarty (2013) mentioned that bleaching with sodium hydroxide (10%) + sodium silicate (10%) + hydrogen peroxide at 70oC (hot) gave the best results for pipal and champa with maximum sensory attributes. Saima *et al.,* (2015) reported the effectivity of 20% hydrogen peroxide and "Ala" (15%) on bleaching of venation skeletons used for a maximum of 2 hours. Preethi *et al.,* (2019) recommended 100% sodium chlorite for bleaching of dried plant materials like *Wedelia trilobata, Clitoria ternatea, Mussaenda luteola, Caesalpinia pulcherrima 'flava', Mussaenda luteola, Hamelia patens, Thryallis glauca, Ixora duffii, Ixora coccinea, Caesalpinia pulcherrima, Saraca indica, Cordia sebestena,* and *Cassiaglauca.*

8 Coloring

Coloring or dyeing is important to enhance the beauty of dry flowers and other aesthetic products prepared from them. The main disadvantage of dried botanicals is that the color fades in a shorter period of time, so choosing the appropriate dye that can persist for a longer period is important to make flowers and other products more valuable and appealing. The preserved plant material can be dyed with a number of dyes and can be arranged manually.Tampion and Reynold (1971) described three procedures for coloring the plant material: (i) absorption (cut stems are dipped in a dye solution), (ii) dusting the flowers (with powdered dye), and (iii) dipping the cut blossoms in a dye solute. When using the dipping method, a few drops of washing up liquid or surfactants can be added to the dye solution to promote contact between the dye tub solution and the plant material and therefore boost dye molecule diffusion. The absorption process can be used to dye carnations, chrysanthemums, star flowers, gypsophila, and hydrangea. Vat dyes are the best way to dye celosia plants at 0.2 percent concentration by cold process. They also suggested using culinary dyes to dye the dried plant parts, which come in a wide range of colors and are safe to use. For coloring the seeds and pods, dip dyeing and spraying are usually recommended.

9. Packing and Storing of Dry Flowers

Dry flowers and leaves are delicate and brittle and require special treatment and preservation. They should not be handled roughly during transportation and distribution. The moisture content of dried flowers frequently affects their shape and form. Lower moisture content leads to stiffness, while higher moisture content consequences flaccid flowers.

The flowers dried in silica gel reabsorb atmospheric moisture and lead to a loss in shape. As a result, they should be kept in a closed container, such as glass desiccators, tin boxes, and cartons coated in

plastic sheet or wax paper, wherein silica gel crystals are kept at the lowest possible level. The storage packaging containers should be dust-free and protected from direct sunlight to hold color. Plant materials dried in sand must be stored in a sturdy carton to shield the petals from breaking. Packaging for fragile dried plant materials should be accomplished manually at some point of transportation and distribution. The quality of the cartons or boxes for packaging of dried plant material should always be superior, dust free, and should be wiped clean every so often. The dehydrated plant material can always get affected by insect pests, and these could be controlled by insecticides carried out within the strong pest strips (dichlorvos), liquid (synthetic pyrethroids, ethyl parathion 0.01%), or gasoline (methyl bromide, phenyl capsules). The common fungi affecting the dried plant material are Aspergillus, Penicillium, and Rhizopus. To prevent the desired plant material from such infection, it should be treated with Dithane M-45 (0.2%) before collection (Suhrita *et al.*, 2021). Sulfur burning or sulphur dioxide fumigation also decreased these fungi throughout storage. Oulakh and Radha Rani (2018) reported that specific display packaging substances may be used to enhance the appearance of the products and, additionally, to keep the general quality of the dried flowers for a longer duration. Sharma *et al.* (2019) reported that most of the score was allocated to plant material dried in a microwave oven and stored covered in paper envelopes for as much as a hundred and twenty days in storage. In case of dyed flowers, most presentability was discovered in flowers dyed with yellow fabric dye and stored in paper envelopes.

10. Conversion of dry flowers into value added products

Dry flowers obtained from different dehydration techniques (Fig.1b) can be used in the production of diverse economically useful products such as artistic greeting cards, wall hangings, gift cards, calendars, table mats, coasters, candle decorations (skeleton leaves can be embedded in earring/pendants to make the jewellery more beautiful), different dried flower arrangements, and floral designs of numerous varieties with no limits. A dynamic splash of vibrant and breath taking dried flowers can be composed beautifully in several forms or arrangements. A selection of interior design baskets and other whimsical containers are used to enhance any interior design scheme. These arrangements form the best décor accents and gifts. They add a touch of elegance, enhanced beauty and cheerfulness to any office or home. They form a unique gift that adds an undeniable charm and brings a smile to just about any occasion. Dried flowers, twigs, and grasses also enhance the dried flower arrangements. A few silk flowers, ribbons, or bows added to the arrangement ensure a more delicate and sophisticated look. There are a number of different dried floral arrangements, including dry flower bouquets, mixed potpourris, bridal bouquets, basket bouquets, swags, garland, dry flower sachets, and dry flower wreaths. The use of dried flowers has made it possible to enjoy their beauty for several years. One just needs to explore some wild imaginations to get a beautiful, attractive, enthralling, and long-lasting piece of dried flower art. Some of the dried flower items are discussed as follows.

Greeting cards

Dry flowers can be used to create beautiful and artistic greeting cards. The greeting card requires card paper, as well as a preferred background of matching floral material, which is picked and arranged on the card paper according to the desired design and adhered to it with adhesives. Similarly, this method can be used to prepare a variety of other valuable artefacts.

Potpourris

Potpourris is a mixture of dried plant parts with a sweet aroma, such as flowers, leaves, seeds, stems, and roots. A fixative is required for the preparation of potpourris, as it is responsible for absorbing and slowly releasing the aromatic oils. Potpourris (room fresheners) are becoming increasingly popular as gifts and personal things. Potpourris can be made from rose petals, gomphrena, marigold petals, and lotus pods. For smell, use herbs like artemesia, thyme, sage, rosemary, basil, achillea (yarrow), lavender, scented geranium, mint, marjoram, verbena, anise, and fennel.

Fig.1b. Dried flowers

Dry flower arrangements

Dry flowers and foliage can be used for designing specific, charming, and artistic flower arrangements, which can be used for interior decoration purposes. They can be arranged in different vases just as fresh-cut flowers are arranged. The flowers, including roses, statice, straw, paper flower, billy button, nigella, briza, brumus, larkspur, roses, lavender, achillea etc., along with dried grass seed heads and pods, are mostly used in dried flower arrangements.

11. Summary

Dry flowers offer significant opportunity to increase a farmer's earnings throughout the year, regardless of the hazardous climatic conditions encountered on open farms. Dry flowers can be formed by simple drying methods in which, along with reduction of water content, the colour and shape of flowers are retained to a maximum extent, so as to preserve their beauty and hence their value. The dried flowers and foliage obtained from press drying can be used in the preparation of innumerable craft items such as artistic greeting cards, calendars, landscapes, wall plates, wall quilts, visiting cards, photo frames, candle holders, handmade paper, lamp shades etc. whereas, dry flowers obtained by silica gel drying and oven drying can be used in the creation of various flower arrangements for interior decoration, as the products obtained through these methods are superior in terms of colour and shape retention. Additionally, the skeleton leaves can be used in any dry flower arrangement to add their beauty. Similarly, dry flowers obtained from other drying methods can also be utilised in the preparation of various value added products. Hence, dry flowers have a wide scope of use, especially for unemployed youth, housewives, and rural women, as countless valuable items can be made utilising dry flower technology. It can start up with a limited scale industry which can be controlled by women from

their homes. Women can work collectively to create numerous profitable craft items and can act extraordinarily to build up new business sectors. The dried flower business is a futuristic business model at an international level, and it's still an underexplored opportunity in the Indian scenario. It is one of the potential technologies for self-employment and to empower people. It can be beneficial to physically handicapped people and women, especially to socio-economically weaker sections of society. Proper training, awareness, motivation, and funding can encourage the physically challenged, housewives, and rural women to start small-scale ventures in this business opportunity. The technology, skills, and investment for these ventures are nominal and can be a big boost to the creativity and income level of rural society. Awareness can be raised through workshops, exhibitions, and training programmes by which individuals could be directed to achieve sustainable livelihood and income by converting agro-items into value-added products.

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References

[1]. APEDA) http://apeda.gov.in/apedawebsite/index.html
[2]. Anonymous (2009) Area and Production of flowers. National Horticulture Database
[3]. Anonymous (2009) Production and Productivity of flowers in Maharashtra. Source Indian Horticulture Database.
[4]. Anonymous (2008-09) India's total export of floriculture products in the year
[5]. Anonymous(2001) Dry flower technology. Website: www.technopreneur.net/newsletters/meg/archives/v14n7.pdf
[6]. Bhattacharjee SK, De LC (2003) Dried flowers and plant Parts. In: Advanced commercial floriculture Jaipur: Avishkar Publishers.162-73
[7]. Bhutani JC (1990) Capturing nature, a way with flower Everlastings. Ind. Hort 34(4): 15-19.
[8]. Brown SP, White P, Tija B, Sheehan MR (2013) Drying and preserving plant materials for decorative uses. Available: https://edis.ifas.ufl.edu/pdffiles/EP/EP00400.pdf
[9]. Bryan L (1992) Drying flower and herbs. Harlexton Publishing Ltd. Linecolnshire (U.K.). 48p
[10]. Christy Pat (1999) Preparing and selling herbs and dried herbs. Website: www.cenyc.org/files/citylot/prearngsellingherbsdriedflowers.pdf
[11]. ChenW, Gast KLB, Smithey S (2000) The effects of different freeze-drying processes on the moisture content, colour and physical strength of roses and carnations. Sci Hortic 84(3/4):321–332
[12]. Dubois P (2005) Farnote 10/89: drying cut flowers and foliage. Website: www.agrc.wa.gov
[13]. Dana M (1983) Preserving plant materials. Extension Publication HO-102, Purdue University, Indian. 4p
[14]. Dana Michael, Lerner B Rosie (2002) Preserving plant materials. Website : http://www.agcom.purdue.edu/agcom/pubs/menu.htm
[15]. Datta SK, Gupta Y C (2021) Floriculture and Ornamental Plants, Handbooks of Crop Diversity: Conservation and Use of Plant Genetic Resources,pp 1-43. https://doi.org/10.1007/978-981-15-1554-5_21-1
[16]. Datta SK (1997) Dehydration of flowers and foliage and floral craft. NBRI Bulletin No 3. EBIS, NBRI, Lucknow, 20p
[17]. Datta SK (1999) Dehydrated flowers and foliage and floral crafts. In: Bose TK, Maitti RG, Dhua RS, Das P (eds) Floriculture and landscaping. Naya Prokash, Kolkata, pp 696–70
[18]. Gurumurti N (1997) Dried flowers offer bright prospect for Indian entrepreneur. Floriculture Today 2(1)33- 34.
[19]. Gupta Deshraj, Prashant K (2005) Standardising dehydrated technology for ornamental plant parts of shrubs from outer Himalayas. J. Ornamen. Hort8(1): 53-55.
[20]. Joyce DC (1998) Dried and preserved ornamental plant material: not new, but often overlooked and underrated. ActaHortic 454(454):133-46
[21]. Kumar Parmar P (1998) Preserving flowers and foliage. Kisan World 27:63.
[22]. Kher MA, Bhutani JC (1979) Dehydration of flowers and foliage. Extension Bulletin–2 NBRI, Lucknow. 20p
[23]. Lawrence HMG (1969) Taxonomy of vascular plants. Calcutta: Oxford and IBH Publishing Co. Inc; 777 p.
[24]. Murugan PA, Thiyagarajan G, Ramesh K.(2007) Dry flower technology. Website: http://www.techno-preneur.net/informationdesk/

sciencetech-magazine/2007/Dec07/Dryflower.pdf[cited18/8/2020].
[25]. Mayak S, Halevy AH (1980) Flower senescence. In: KV Thimann (ed), Senescence in plants. CRC Press, Boca Raton. 132p
[26]. Marak DW, Chakrabarty S (2013) Standardization of drying techniques for leaves of pipal (Ficus religiosa), Banyan (Ficus bengalensis) and silver oak (Grevillea robusta). Green Farming 6(6):1388–1391
[27]. Oulakh B, Radha Rani P (2018) Quality characteristics of dried flowers as influenced by packaging materials. Indian J Hortic 75(3):498–499. https://doi.org/10.5958/0974-0112.2018.00084.1
[28]. Puri A. Economic potential of dried flowers. *Agricultural Marketing.* 1995; 36(1): 43–46.
[29]. Prasad JJK, Pal PK, Voleti SR (1997) Drying of flowers: an upcoming industry. Floriculture Today 4(6):20-23
[30]. Paul D, Shylla B (2002) The art of flower drying. In: Mishra RL and Mishra S (eds). Floriculture Research Trends in India 41-46p.
[31]. Padmavathamma P (1999) Standardization of drying technique for statice cut flowers. M.Sc. Thesis, UAS, Bangalore, Karnataka (India)
[32]. Pandey PH (2001) Principles and practices of post harvest technology. Kalyani Publishers, Ludhiana
[33]. Ranjan JK, Misra S (2002) Dried flowers: a way to enjoy their beauty for a long period. Indian Hortic 47(4)32-3
[34]. Saima Rashid Mir, Jana MM, Naik RH (2013) Standardization of preservation techniques of natural leaves for dry arrangements. Current Horticulture 1 (1) 7-10
[35]. Saima Rashid Mir, M.M. Jana (2015) Preparation of leaf venation skeletons of leaves for dry flower arrangement. Curr Hortic 3(1):53–56
[36]. Saima Rashid Mir, Shinde BM, Chaskar MG, Jana MM (2019) Review of literature on dry flowers. Res Rev.J Life Sci 9(2):52–55
[37]. Saima Rashid Mir, Shinde BM, Chaskar MG, Jana MM (2019)Dry flowers & floral craft: For better subsistence & women empowerment. International Journal of Research & Analytical Reviews 6 (1) 209-213
[38]. Saima Rashid Mir, Shinde BM, Patil VA, Jana MM (2020) Studies on Comparative Techniques for Dry Flower Production. Int J Pharm Sci 11(4)107-112
[39]. Saima Rashid Mir (2020) Conversion of leaf venations to flowers. Agriculture Observer 1(2):36-39
[40]. Saima Rashid Mir (2021) Studies on methods of drying flowers and leaves. Bioinfolet 18(2):248-251
[41]. Saima Rashid Mir,Shinde BM, Sonawnae HB (2021) Studies on different drying methods in ornamental flowers concerning quality dry flower products. International Journal of Agriculture Sciences. 13(10),10894-10896.
[42]. Saima Rashid Mir, Shinde BM(2021) Comparative study on different drying methods in rose. Hybrid tea, Floribunda & Miniature. Wesleyan Journal of Research.14 (28), 54-59. ISSN: 0975-1386.
[43]. Safeena SA, Patil VS, Naik BH (2006) Standardization of stage of harvest for better quality of dry flowers of rose. JOrnitholHortic 9(3):224-6.
[44]. Singh A, Dhaduk BK, Shah RR (2004) Effect of different temperature and embedding media on flower dehydration of zinnia (Zinnia linearis Benth.). Indian J Hortic 61(3):249–252
[45]. Singh HP (2009) Floriculture industry in India: the bright future ahead. Indian Hortic 54(1)3-8.Susan (1990) Dried flowers. Merchants Ltd, Ferry House, London,United Kingdom.144p
[46]. Shailza, Shalini J, Grewal HS (2018) Emerging prospective of floriculture industry: drying of ornamental plants and their parts. Int J Curr Microbiol Appl Sci 7(7):1619–1633. https://doi.org/10.20546/ijcmas.2018.707.190
[47]. Sharma G, Kashyap B, Gupta YC, Sharma BP (2019) Studies on keeping quality of dried and dyed chincherinchee flowers. Indian J Hortic 76(3):552. https://doi.org/10.5958/0974-0112.2019.00089.6
[48]. Sushil Kumar, Arvind Malik, Vikash Hooda (2021) Journal of Pharmacognosy & Phytochemistry 10(1): 27-31
[49]. Sujata AN, Damodaran T, Shiva KN (2001) Dry flower industry in Andamans., Kissan World. 28:28.
[50]. Sell R (1993) Dried and fresh cut flowers. NDSU Extension Service, North Dakote State University of Agriculture and Applied Science. USA. 62pp
[51]. Smith RC (1993) Methods of preserving flowers. NDSU Extension Service, North Dakote State University of Agriculture and Applied Science, USA
[52]. Sushil Kumar, Arvind Malik, Vikash Hooda (2021) Journal of Pharmacognosy & Phytochemistry 10(1): 27-31
[53]. Tampion J, Reynolds J (1971) Botany of flower arrangers. Petham Books Ltd., London

[54]. Thakur P, Joshi AK, Chandra A (2019) Epoxy resin encapsulation: a novel drying technique fornative flowers. Indian Hortic 64(4):40
[55]. Thomler J (1997) Drying flowers and leaves. Website: http://www.nectar.com.au./jascraig/craft/drieddf.htm/
[56]. Vahoniya D, Panigrahy SR, Patel D and Patel J (2018) Status of Floriculture in India: With Special Focus to Marketing . International Journal of Pure and Applied Biosciences 6(2): 1431–1438
[57]. Verma AK, Dhimam MR, Kumar D, Gupta A (2012) Preserving flowers and plant parts. In: Postharvest technologies for commercial floriculture. New Delhi: New India Publishing Agency; p. 143-71
[58]. Westland P (1995) Step by step dried flowers. Anness Publishing Ltd. London, United Kingdom. 15-20p
[59]. Westland Pamela (1992) The complete flower arranger. Annes Publishing Limited, London, United Kingdom
[60]. White P, Tijia B, Sheehan MR (2002) Drying and preserving plant materials. University of Florida Co-operative Extension Service.
[61]. White P (2007) Drying and preserving plant materials. Website: www.edis.ifas.ulf.edu/pdffles/ep/ep00400.pdf

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