IMPACT: International Journal of Research in Applied, Natural and Social Sciences (IMPACT: IJRANSS)
ISSN(E): 2321-8851; ISSN(P): 2347-4580
Vol. 4, Issue 3, Mar 2016, 111-120

DRYING TECHNOLOGIES OF COMMERCIAL FLOWERS- AN OVERVIEW

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ABSTRACT

Dry flowers are essential export items both in Indian and International markets and Indian export basket composed of 71% dry flowers which are exported to mainly USA, Japan, Australia, Russia and Europe. The demand for dry flowers is increasing at an impressive rate of 8-10 per cent annually thus offering a lot of opportunities for the Indian entrepreneurs to enter in the global floricultural trade. A number of flowers respond well to drying techniques such as orchids, anemone, zinnia, allium, sweet william, carnation, stock, freesia, narcissus, chrysanthemum, pansy, daffodils, marigold, rose, lilies, foliage like ferns, aspidistra, eucalyptus, ivy, laurel, magnolia and mahonia etc. A number of drying techniques such as air drying, sun drying, press drying, embedded drying, microwave drying, freeze drying, molecular sieve drying and cryo drying, preservation techniques and value addition of dry flowers discussed in details.

KEYWORDS: Dry Flowers, Drying, Preservation

INTRODUCTION

Dried and preserved ornamental products offer a wide range of qualities like novelty, longevity, aesthetic properties, flexibility and year round availability (Joyce 1998). Dry flowers are essential export items both in Indian and International markets and Indian export basket composed of 71% dry flowers which are exported to mainly USA, Japan, Australia, Russia and Europe. The demand for dry flowers is increasing at an impressive rate of 8-10 per cent annually thus offering a lot of opportunities for the Indian entrepreneurs to enter in the global floricultural trade (Singh 2009).The range of dried flowers and other attractive plant parts is quite extensive, namely stems, roots, shoots, buds, flowers, inflorescences, fruits, fruiting shoots, cones, seeds, foliage, bracts, thorns, barks, lichens, fleshy fungi, mosses, sellaginellasetc (Desh Raj 2001).A number of flowers respond well to drying techniques such as anemone, zinnia, allium, sweet william, carnation, stock, freesia, narcissus, chrysanthemum, pansy, daffodils, marigold, rose, lilies etc (Rogers 1988) and foliage like ferns, aspidistra, eucalyptus, ivy, laurel, magnolia and mahoniaetc (Rogers 1967, Healy1986).Otherwise this industry exports 500 varieties of flowers to 20 countries and export of dried flowers and plants from India is about Rs. 100 crores. Potpourri is a major segment of dry flower industry valued at Rs. 55crores in India alone. Easy availability of products from forests, possibility of manpower available forlabour intensive craft making and availability of wide range of products throughout the year are thereasons for development of dry flower industry in India. This industry provides direct employment toaround 15,000 persons and indirect employment to around 60,000 persons.In India, nearly 60% of the rawmaterials are sourced from natural forests and plains, only 40% of the flowers are cultivated for drying,bleaching and coloring. Orchids are beautiful elegant looking flowers that come in variety of colours and they can be used in flower arrangement or dried flower craft and other value added products.

Harvesting of Materials for Drying

For drying, fresh material is required; faded and old flowers and leaves should be rejected. As per requirement, different flowers can be collected at different stages (Paull and Shylla, 2002). The flowers should be cut just as they come to maturity (Padmavathamma, 1999). Flowers harvested at half bloom stage took minimum time for drying (Saffeena*et al* ,2006a) Flowers and foliage should be collected from the field, one or two days after irrigation. The collected materials should be free from surface moisture and dew. Hence it is better to collect the material in the dry season on a sunny day. Flowers or plant parts selected for drying may be sprayed with Dithane Z-78 of Neem based pesticide (0.5%).

Moisture Retention after Drying

Moisture retention in the flowers after drying influences flower shape. The lower moisture content provides rigidity and results in uniform cell contraction in the flowers while the higher moisture content in dried flowers lead to flaccid flowers.

Stronger and stiffer petal in dried flowers having low moisture content (Chen *et al*, 2000). A range of 8-11.5 per cent moisture content in the dried flowers will ensure good quality and firmness and maintains keeping quality for more than six months. Excessive drying of flowers resulted into petal shedding during handling (Singh 2004). Drying below 8 per cent moisture content showed shedding effect which might be attributed to excessive loss in moisture, that might have resulted into weakened adhesion and cohesion forces in flower tissue and might have caused softening of the middle lamella leading to abscission.

Methods of Drying

Several methods are practised for dehydration of flowers and foliage. In these methods, removal of moisture from flowers and foliage is done. Drying is generally done under artificially produced heat and controlled temperature, humidity and airflow. For removal of water from fresh flowers and plant parts, optimum temperature to be determined, otherwise quality of the product will be affected. The different drying methods are discussed below (Bhutani 1990, Bhalla and Sharma 2002).

Air Drying: This is the most common method which is widely used for long lasting seasonal flowers which are crisp in texture. They are hung in an inverted position or kept in an erect manner. Air drying requires a warm clean dark and well ventilated area with low humidity (Raghupathy*et al* 2000). Flowers may also be spread over blotting sheets/news papers and kept in dark or in the sun (Datta, 1997). Time taken for drying depends upon room temperature, relative humidity, air flow and moisture content of the flowers. The disadvantage faced by this technique is the shrinkage of petals in most of flowers.

Sun Drying: Plant material is embedded in drying medium (sand) in a container and exposed to the sun daily to facilitate rapid dehydration. In India, open sun drying is followed for drying many flowers.

Water Drying: Some flowers dry well if placed in water. The stems of the flowers are initially placed in a couple of inches of water, then the water is allowed to evaporate and be taken up by the cut flowers. The container and flowers should be in a dry, warm and dark location. Hydrangeas, yarrow, bells-of-Ireland and celosia dry well with this method.

Press Drying: The flowers and leaves are placed between the folds of newspaper sheets or blotting paper. To

ensure uniform pressure, flowers for press drying should be spread uniformly on blotting paper. These sheets are kept one above the other and corrugated boards of the same size are placed in between the folded sheets so as to allow the water vapour to escape (Bhutani, 1990). It should be given slight pressure for 24 hours and then kept in an electric hot air oven for 24 hours at 40-45^{o}C (Datta, 1997). The press dried flowers are stored either in sheets at a dry place or in desiccators for future use.Though the flowers and foliages become flat after press drying, yet this material can be used for composing floral craft items like greeting cards, floral designs and other art creations which may be framed for wall pin-ups (Bhutani, 1990).

Embedding: To overcome the problem of petal shrinking, the flowers are dried in an embedding technique. The flowers or leaves are embedded in a drying medium, namely, silica gel or borax or white sand depending upon the plant material. Embedding in silica gel is perhaps the easiest and the best method of embedded drying of flowers (Bhutani, 1993; Dhatt et al, 2007; Desh Raj and Gupta, 2003). These materials cover flowers in such a way that the original shape of flowers is maintained properly. Metallic or plastic or earthen containers are used for embedding at room temperature in a well ventilated room. About 5 cm layer of desiccant is poured in the bottom of the container and the flower stems are pushed into the medium. Flowers are covered and kept at room temperature. This method takes long time but give good drying without altering shape and appearance of the flower. To enhance dehydration, the preparation set is kept under the afternoon sun. After dehydration, the containers are tilted for removing the desiccants over and around the flowers. The dried flowers are either picked up by hand or by tweezers.

Embedded drying with borax at 50^{o}C was found successful in *Vanda teres*, *Dendrobiummoschatum*, *Arundinagraminifolia*, *Den.* 'Madam Pink', Den. 'Lervia', Den. 'A. Abraham', *Phal.* 'Casa Blanca' ,Phal. 'Detroit' and *Oncidium* 'Sweet Sugar' and embedded drying with borax at 60^{o}C was found successful in *Epidendrum* spp., *Cattleyabowringiana* and *Cattleya* hybrids, Phal. 'Ox Plum Rose x Black Jack' and Den. 'Big White' (Table 1).

Table 1: Embedded Drying of Orchids in Oven with Borax

Name	Temperature	Duration
Vanda teres	50^{o}C	36 hours
Den. 'Madam Pink'	50^{o}C	60 hours
Phal. 'Casa Blanca'	50^{o}C	180 hours
Phal. 'Detroit'	50^{o}C	180 hours
Den. 'Lervia'	50^{o}C	60 hours
Den. moschatum	50^{o}C	60 hours
Den. 'A. Abraham'	50^{o}C	60 hours
Onc. 'Sweet Sugar'	50^{o}C	60 hours
Arundinagraminifolia	50^{o}C	60 hours
Epidendrum spp.	60^{o}C	27 hours
*Blc';*Guanmiau City', *Cattleyabowringeana*	60^{o}c	21 hours
Den. 'Big White'	60^{o}C	21 hours
Phal. Ox Plum Rose × Black Jack	60^{o}C	9 hours

Figure 1

Embedded drying with borax and silica gel at 55°C was found successful *Coelogyneflaccida*, *Coelogynecristata*, *Dendrobiumnobile*, *Dendrobiumwilliamsonii*, *Dendrobiumaphyllum*, *Den*, 'Erika', *Den.* 'Big White 4N', *Den.* 'Bangkok Blue', *Paphs.*'Nagasaki' and *Cym.*'Sungold'.

Table 2: Embedded Drying of Orchids in Oven with Borax and Silica Gel (1:1)

Name	Temperature	Duration
Dendrobiumnobile	55°C	10 hours
Dendrobiumwiilliamsonii	55°C	10 hours
Dendrobiumaphyllum	55°C	10 hours
Den. 'Erika'	55°C	12 hours
Den. 'Big White 4N'	55°C	12 hours
Den. 'Bangkok Blue'	55°C	7 hours
Coelogynecristata	55°C	10 hours
Coelogyneflaccida	50°C	7 hours
Paph. 'Nagasaki	55°C	10 hours
Paph. 'Sun Gold'		14 hours

Figure 2

Oven Drying: To get the superior product, oven drying is the best method. The drying time can be reduced if the stalks are kept in an oven at an appropriate temperature. The embedded plant material is kept in the hot air oven at a controlled temperature for an appropriate time. But care must be taken in the drying temperature and duration of drying. Electrically operated hot air oven at a controlled temperature of 40-50°C c is usually used for drying flowers in an embedded condition. Rapid drying techniques at higher temperatures have been documented by Singh et al, 2004, Chen *et al*, 2000; Raju and Jayanthi, 2002; Safeena*et al*, 2006b).

Microwave Oven Drying: The principle behind the microwave oven drying is liberating moisture by agitating water molecules in the organic substances with the help of electronically produced microwaves (Bhutani, 1990). This is the quickest method of drying. Embedded flowers and foliage in silica gel contained in non-metallic earthenware or glassware are kept in such an oven for a few minutes to induce effective drying (Bhutani, 1995). The standardized time limit should be followed. After the treatment, the containers are taken out and kept at ambient temperature for a particular period, so

that the moisture of the container evaporates and the plant material gets fully dried. This process is called ‘setting time’. The drying period and the setting time varies with the type of flowers; and it varies from one to four minutes. Setting time vary from 2 to 5 hours.Thomler (1997) reported that microwave oven drying was more suited for cluster of florets such as golden rod, gypsophilla and corn flower. White *et al* (2002) reported that microvwave oven dried flowers looked fresh and more colourful than obtained by other methods.

Freeze Drying: Freeze drying is used for preserving flowers and is particularly popular for wedding bouquet preservation. Petals can also be freeze dried and used for decorations at weddings, dinner parties and other occasions, for decorating cakes and scattering on tables etc. Freeze drying flowers uses a process called lyophilization to lower the temperature of the flowers to below freezing, and then a high-pressure vacuum is applied to extract the water in the form of vapour. The vapour collects on a condensing surface outside the chamber, turns back to ice and is removed. Finally, a gradual temperature rise extracts all remaining 'bound' moisture from the flowers. This process retains the original shape and structure and preserves the flowers. Flowers like Alstroemeria, Amaranthus, Aster, Bird of Paradise, Calla Lily, Carnation, Cattleya Orchid, Daffodil, Dahlia, Delphinium, Dendrobium Orchid, Dianthus, Freesia, Gardenia, Gladiolus, Gypsophilia, Hyacinth, Hydrangea, Iris, Liatris, Lily of the Valley, Lisianthus, Narcissus, Peony, Phaleonopsis Orchid, Rose (all varieties) and Snap Dragon can be freeze dried. Freeze drying techniques have been reported by various workers (Dubois and Joyce, 1989; Ruth, 2000; Brown, 1999).

Molecular Sieve Drying: Molecular sieve is a material containing tiny pores of a precise and uniform size that is used as an absorbent for gases and liquids. They are metal alumino silicates which have a crystalline structure consisting of an assembly of tetrahedral. The tetrahedral are made up of four oxygen atoms which occupy the summits surrounding either one silicon atom or an aluminium atom placed in the center. Compensating cations (sodium, potassium) make the hole electrically neutral. The hole forms an assembly of small cells (or pores) of uniform and known size, in which a molecule of smaller size can be trapped by the phenomenon known as absorption. To ensure the dehydration of the fresh natural flowers the mixture of organic solvents is poured onto the hole until the level exceeds the level of the flowers by about 2 cm. The water molecules are progressively absorbed into the small cells or pores of the molecular sieve. The receptacle is closed hermetically for a few days. Once dried, the flower reabsorbs a little moisture of atmospheric origin, and this increases its suppleness and its plasticity.Flowers which are particularly suitable for such a treatment are roses, peonies, camellias, marigolds, globe flowers, orchids, dahlias, carnations, phloxes, summer chrysanthemums, hollyhocks, and the like, and other species with many petals or a fairly rigid structure.

Cryo Drying: The fully open flowers are cut into a uniform 15cm length and placed in vials so that the basal 5 cm is immersed in solution of glycrerine, clove oil, ethylene glycol, dimethyl sulphoxide and wetting agent. After that the flower stems are recut to 5cm in length and placed in a freezing temperature at -80^{o}C for 12 hours. Then the flowers are immediately placed in a freeze dryer at 20^{o}C under a vacuum of less than 100 microns for 7 days. A minimum of 7 days is required for the flower and stem tissues to be totally dry.

Drying with Glycerine: In this method, the angular cut stem ends of berries and leafy material can be dried with their lower ends dipped in a mixture of 1:4 glycerine and water for 3 to 6 days for soft stems and 6 weeks for woody stems.Many types of foliage have been successfully preserved by either immersing leaves or placing crushed stems in a 33 per cent glycerol solution.Being an osmotic agent, glycerine replaces the water content of the tissues (Joyce, 1998). After

treating with glycerine, the plant material can be microwaved.

Silica Gel Drying: The ground crystals of silica gel are placed in a layer, then of flowers are kept and the flowers are kept with crystals in a tin container or jar that can be covered. Within 2 to 3 days, the crystals will turn pink and the flower heads will be farm to the touch. At this point, the dried flowers are removed. The silica gel can be re-used.

Borax Drying: Borax is best suited for dehydration of delicate flowers. These are best mixed with equal parts of sand. Bhattacharjee and De (2003) suggested that borax and alum being light in weight could be used for dehydration of flowers. Borax being hygroscopic in nature might bleach flower petals if embedded for a long time (Datta 1997). Smith (1993) reported that flowers like rose, aster, carnation, marigold, dahlia, larkspur, geranium, zinnia, chrysanthemum and delphinium could be dried well in borax. Drying through borax will take 2 to 10 days. To prevent spotting, all the desiccants should be removed from the flowers after drying. A mixture of one part of borax to one to three part of corn meal mixture is satisfactory for rapid drying. One table spoon of salt may be added to speed up drying process.

Sand Drying: Sand can also be used for drying. Fine sand has been found to be the best material for embedding because it is easy to handle, heavy and doesn't react with water vapour (Datta 2001).Organic materials and salts are strained from the sand before use. Since sand is heavier, it takes a longer time for drying than the other desiccants. Drying through sand takes four days to two weeks. A mixture of two parts of borax to one part of sand may be used, adding one tablespoon salt to each quart to speed drying.

Other Drying Techniques: Other desiccants used in drying techniques are expanded clay, kitty litter, perlite, dry saw dust, rice husk and corn starch.Under room condition, perlite can be used for drying of spikes and florets of orchids within 15 to 20 days.

Figure 3

Special Preservation Techniques

Skeletonizing: This treatment eliminates all tissues but the "skeleton" or veins of leaves. Skeletonized leaves lend an interesting, lacy appearance to dried arrangements. Heavy-textured leaves are the best selects for this method of preservation. Leaves are boiled for 40 minutes in 1-quart water and 2 tablespoons of lye and rinsed in cold water and scraped or brushed the green pulp from the leaves without destroying the network of veins. To lighten the color of the leaf skeletons, immersed in a 1-quart water and 2 tablespoon household bleach solution for 2 hours followed by rinsing and

drying.

Bleaching

Bleached ornamental plant material provides a striking appearance when arranged with dried or dyed flowers. Bleaching also permits the use of dyes for colouring. Oxidative (Hypochlorite, chlorite and peroxide) and reductive bleaching chemicals (Sulphite and borohydride) are used for bleaching ornamental flowers and foliage. Sodium chlorite is an excellent bleaching agent because it is relatively selective for lignin without damaging fibre. In reductive bleaches, hydrosulphites (Sodium or zinc hydrosulphite) are cheap and have maximum bleaching power. After bleaching with oxidative or reductive chemicals, yellowing of the plant materials is the main problem. To avoid yellowing, multi -step bleaching i.e., alternating oxidative bleach with a reductive bleach create products with less yellowing. A final wash in a 2 % solution of barium hydroxide, calcium hydroxide, sodium bicarbonate or aluminium sulphate prevents yellowing.

Coloring Dried Flowers

Preserving flowers with their natural colour is essential otherwise it will be essential to improve the colour of the product by adding dyes. A dye is most often added to the glycerine preserving solution to permanently colour the decorative plant materials. Systemic dyes are available for use. They are acidic–anionic dyes, which are combined with water and glycerine to form a preservation solution that is absorbed by fresh cut flowers and foliage through the stem of the plant. As the water evaporates, it leaves behind the dye and glycerine for our desired colour. Normally 1.5 ml to 5 ml dye/l of solution is prepared. Colorintake and preservation will require 2-8 days.

Sulphuring

It is used to prevent enzymatic colour change. Traditionally, sulphur granules have been burnt for about 2 hours in a closed chamber along with dry flowers. It is very toxic and therefore, it is advised to check relevant safety instructions.

Potpourri

Potpourri is usually a mixture of dried, sweet-scented plant parts including flowers, leaves, seeds, stems and roots. The basis of a potpourri is the aromatic oils found within the plant. Two kinds of potpourri can be made - dry and moist. The most common, the dry method, is

quicker and easier, but the potpourri does not last as long. Both methods require a "fixative", for absorbing the aromatic oils and slowly releasing them. Herbs such as Artemesia, Thyme, Sage, Rosemary, Basil, Achillea (Yarrow), Lavender, Scented Geranium, Mint, Marjoram, Verbena, Anise and Fennel can be used for scent. The herbs and fruits should be thoroughly dried to prevent mildew.

Uses of Dry Flowers

Dry and pressed flowers can be used for many purposes. They can be utilised in the best manner for making decorative floral craft items, greeting cards and covers, wall hangings, floral designs, calendars, floral balls, festive decoration and other creative displays. Floral albums may be prepared with these items for identification of plants for botanical studies. A cottage or small scale industry based on floral crafts using dehydrated flowers, leaves, fruits, pods, seeds and other parts in a distinct possibility. Dehydrated plant parts may be arranged aesthetically and covered with plastic or trans parent glass to protect them from atmospheric humidity, wind and dust. For interior decoration, dry flowers sealed

in glass containers may be used. The dry flower industry can be associated with many subsidiary industries like cotton fabrics, terracotta, packaging, cane, basket and glass, jute, iron and brass, ribbons and laces, candles etc. by incorporating one with the other, one can have the benefit of value addition.

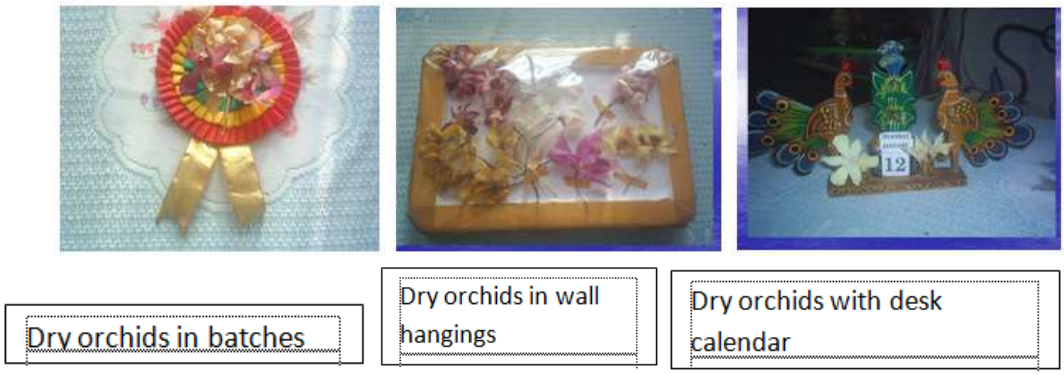

Figure 4

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