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Refinement of Technology on Dry Flowers: A Review

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ABSTRACT

Dry flower market has grown exponentially as consumers become eco-conscious and choose dry flowers as eco-friendly and biodegradable alternative to fresh flowers. Dried flowers and other plant parts are nature's everlasting gift which can be treasured over years. They have tremendous potential as substitute for fresh flowers and foliage as their charm can be maintained from few months to years with lesser cost. The market demand of dry flowers and ornamentals is increasing day by day and can become lucrative income generating hobby for entrepreneurs in India either by producing or marketing dried flowers and ornamentals.

Key words: Bleaching, Dry flower, Dyeing, Eco-friendly, Everlasting, Ornamentals.

Flowers are important part of our lives. The catching sight of flowers growing in all their grandeur and simplicity makes it tempting to wish the season to continue for never ending. Fresh flowers are though exquisite in their beauty but short lived and available during particular season. Besides this, the beauty and freshness of cut flower and foliage is also lost due to microbial activities and biochemical changes. Dried flower products are long lasting and retain their aesthetic value irrespective of the season (Hiller, 1994). Dried ornamental plant parts are generally less expensive and are sought for their everlasting and attractive appearance (Smith, 2000). The art of flower drying is a very old practice. Earlier dried flowers were in practice in the form of herbarium made by botanists for the purpose of identification of various species (Prasad *et al.,* 1997). In the modern era of eco-consciousness, use of natural plant products like dry flowers, petals, leaves, stems, seeds, roots, *etc* has become the foremost choice of the urban people in their lifestyles for interior decoration as well as for aesthetic and commercial uses (Datta, 2007).

Indian floriculture industry has been shifting from traditional flowers to cut flowers and dry flowers for export purposes. The most promising area in floriculture is the dry flower industry which is growing very fast with more than 60 per cent share to the floriculture industry in India. Dry flowers and their products constitute more than two-third of the total floriculture exports from India. 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). Raw materials in bulk quantity are being exported from India to the developed countries like UK, Japan and America, where dried floral arrangements are of great demand. Dried and preserved ornamental products offer a wide range of qualities like novelty, longevity, aesthetic properties, flexibility and year-round availability (Joyce, 1998).

What are Dry flowers?

Dry flowers are nothing but dehydrated flower botanicals and parts of plants. Anything from flowers to petals, buds, stems, roots, fruits and leaves in a dried form come under the domain of dry flowers. These dehydrated plant parts can be used in natural, dyed, bleached or preserved forms (Datta, 2007). Dried flowers are product of dehydration and devoid of moisture. The art of dry flower technology gives an opportunity to dried specimens to be freed from the bondage of seasons and to be used in a number of ways for pleasure or for profit (Kher and Bhutani, 1979), they are long lasting and are in demand throughout the year (Susan, 1990).

The life of the dried flower varies according to species, texture of their petal and total consistency of flower (Safeena and Patil, 2013). The demand for dry flowers, dried floral arrangements and floral crafts has increased manifold during the last decade. Dry flowers constitute more than two-third of the total floriculture exports. In India, dry flower industry is mostly concentrated in Tamil Nadu, West Bengal, Andhra Pradesh and Karnataka.

Selection of flowers and foliage suitable for drying

Almost all plant materials from flowers, foliage and branches to seed pods, grains, cones, nuts, berries and other fruits can be dried (Musgrove, 1998). Selection of a suitable crop for drying purpose is very important for the success of the industry (Mishra *et al*., 2003). Deshraj (2001) reported that stems, twigs, branches, bark, leaves/foliage, flowers, thorns/ spines, fruits, cones, seeds, roots, lichens, fleshy fungi,

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mosses, ferns, *etc.* can be utilized for making various value-added floral crafts and flower arrangements which are non-perishable and have longer life. A number of flowers respond well to drying techniques such as anemone, zinnia, allium, sweet william, carnation, stock, freesia, narcissus, chrysanthemum, pansy, daffodil, marigold, rose, lily *etc* (Rogers, 1988) and foliage like ferns, aspidistra, eucalyptus, ivy, laurel, magnolia and mahonia *etc* (Rogers, 1967; Healey,1986). Plant materials like cones, seed pods, grasses, berries and grains found in the garden as well as in fields and along roadsides, can be collected in the fall and winter and used directly in arrangements after gathering. Gouin (1994) suggested that plants for preserving can be collected throughout the year. Flowers at different stages of development can be picked for drying purpose. After cutting, strip the leaves from the stem, since foliage on the stems does not dry properly. In some cases, after drying the flowers lose their ornamental value. Sangama (2004) observed that after drying, petals of helichrysum flower reflex downward, centre disc florets shed and the flower loses its shape. Sweet pea flowers when pressed dry lose their colour and become dark brown which is not suitable for further use (Jean and Lesley, 1982).

Stage of harvesting

The best time for harvesting flowers and other plant parts is late in morning, when the dew is evaporated. In order to avoid wilting, immediately after harvest the plant material should be placed in water container. Fully hydrated plant material preserves the best. The stage of harvesting for different flowers varies according to the species and the form of flower desired (Paul and Shylla, 2002). Sangama (2004) reported that helichrysum flowers harvested at fully open stage took lesser time for drying than those harvested at tight bud and half open stage. Flowers harvested at half bloom stage took minimum time for drying (Safeena *et al.*, 2006a). Lourduswamy *et al.* (2001) found that full bloom of gomphrena and both half as well as full bloom of French marigold and zinnia are the ideal harvest stages for dry flower production. However, usually flowers are harvested just before they are fully open and the colour has not faded (Padmavathamma, 1999). The dry grasses, seeds, pine cones and most seed heads are harvested at full maturity stage at the end of their growing period (Sankari and Anand, 2014). Harvesting of flowers and foliage at suitable stage is helpful in storage and utilization for drying industry. According to Kofranek and Halevy (1972) faster dehydration may be due to the reason that flowers loose moisture as harvesting time is delayed due to the sensitivity of the flower tissues to ethylene, hence flower must be harvested at proper time.

Prasad *et al*. (1997) found that harvesting during dry or summer months gave excellent results as most of the water gets evaporated easily. Brightest colours were produced during monsoon or winter season but the plants were very much susceptible to pests and diseases.

Moisture content in dried flowers

Moisture content is one of the major factors that determines longevity and storability of flowers. The vase life, attractive appearance and longevity of flowers mostly depend on the presence or absence of moisture content within the petal and sepal (Kant and Arora, 2012). The moisture content in dried flowers influenced the longevity and ultimately their quality as it was observed that the moisture content was inversely proportional to longevity. Percentage of moisture content must be determined before ensuring drying technique for different flowers. The best preservation of flowers through drying technique requires the moisture range between 8-11.5 per cent in keeping their firmness, quality and longevity more in comparison to below or above this range (Pandey, 2001). Drying below 8 per cent moisture content showed shedding effect which might be attributed to excessive loss of 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. Paparozzi and McCallister (1988) found rapid tissue desiccation in microwave dried statice flowers. Similarly, Wilkins and Desborough (1986) observed vulnerability of flowers to breakage in vacuum dried flowers. The papery structured flower and their low moisture content affect the drying rate (Safeena and Patil, 2013).

Drying/ dehydration methods

Dehydration is an important post-harvest technique for enhancing ornamental keeping quality of flowers as it quickly reduces the moisture content of flowers to a point wherein growth of microorganisms can be prevented and bio-chemical changes can be minimized or brought to a standstill (Singh and Dhaduk, 2004). There are different approaches to dehydrate the flowers other than the drying technique to keep for few days to week but applying drying techniques flowers can be preserved for long time even months to year after drying or dehydration (Deshraj and Gupta 2003). The drying techniques are less expensive, sustainable, need low cost machinery as well as keep their attractive and natural appearance which facilitate the availability of off-season flowers at all the occasion. Moreover, this technique needs less input with less expertise for producing dried products and operating drying industry (Malcolm, 1994). Drying of flowers and foliage by various methods like air drying, sun drying, oven and microwave oven drying, freeze drying and embedded drying can be used for making decorative floral craft items like cards, floral segments, wall hangings, landscapes, calendars, potpourris *etc*. for various purposes (Bhutani, 1990).

Air drying

Air drying is common method for drying flowers and foliage. In this method plant materials are tied up with wire or rope and simply kept hanging in an area having good air circulation. Flowers should be hung dried in a warm and dark place as light will fade flower colour. Good air circulation

is important. If the air is too humid and stagnant, the petals will take too long to dry and colour will change to brown (Laliberte, 2004). Collier and Jett (2002) found air drying as one of the easiest methods of preserving seed pods and flowers which involves no expense. According to Dana and Lerner (2011), air drying works well with plants having semi-dry flowers and stems that do not readily wilt. White *et al.* (2002) observed that more fleshy flowers and foliage took more time for drying. Air drying in vase is suitable for drying flowers like baby's breath, sea thistle, globe thistle, yarrow, straw flower, larkspur, grasses and beech leaves. Bryan (1992) reported air drying as the earliest method to dry rose, larkspur, statice and straw flower. Helichrysum and statice can be easily dried either by hanging them in an inverted position or by keeping them in a container positioned erect till they get desiccated (Bhutani, 1995; Susan, 1990). Rose bunches could be hung dried in shade within 5-10 days (Seaberg, 1997). Kumar and Parmar (1998) found that air drying in shade is applicable during dry season and summer particularly for flowers such as acroclinum, helichrysum and limonium. Crisp textured flowers like anaphilis, delphinium, oregano, rumex and holmskioldia *etc* can also be dried by air drying (Deshraj, 2006).

Press drying

Press drying is the earliest method of preserving flowers. Flowers like candytuft, chrysanthemum, lantana, rose, verbena, euphorbia and leaves like thuja, ferns, silver-oak, etc are suitable for press drying (Lourdusamy *et al*., 2001). In this method flowers and foliage are placed between the folds of newspaper sheets or blotting papers giving some space among flowers. These sheets are kept one above the other and corrugated boards of the same size are placed in between the folded sheets so as to allow the water vapour to escape (Bhutani, 1990). The drying time can be reduced if the sheets are kept in oven at an appropriate temperature (Datta, 1997). Kher and Bhutani (1979) reported that press drying in oven at 35-39°C for 48 hours was optimum for pansy, whereas, 24 hours for the leaves of silver oak, thuja, adiantum, nephrolepis and flowers of hibiscus, haemotoxylon, calliandra, marigold and Cassia. Gill *et al.* (2002) conducted research on standardization of time required for press drying of different cut flower and concluded that rose, carnation and helichrysum required 120, 132 and 72 hours, respectively, for press drying.

Embedded drying

In embedded drying flowers after harvesting, are placed in desiccants like silica gel, river sand, borax, boric acid, aluminium sulphate, saw dust, corn granules, *etc* for drying. Deshraj and Gupta (2003) reported that among the desiccants (boric acid, silica gel, river sand and sawdust) used for dehydration, silica gel (60-120 mesh) was found as best absorbent for removing moisture from flower and foliage followed by boric acid granules. Gouin (1994) listed flowers and leaves like anemone, butterfly weed, chrysanthemum, corn flower, delphinium, gladiolus, rose and pansy suitable for embedded drying in sand. Flowers like small zinnia, marigold, pansy and chrysanthemum embedded in sand in an upside-down fashion and kept in the sun, dry in two days, while, gomphrena, zinnia and French marigold took 3-4 days sun drying (Lourduswamy, *et al*., 2001). Singh *et al*. (2004) found that drying of zinnia flowers in sand resulted in good quality of dried flowers with attractive flower colour and smooth petal texture. Bhutani (1993) reported that embedding in silica gel was perhaps the easiest and the best method of embedded drying of flowers. Flowers like rose, aster, gerbera, marigold, dahlia, larkspur, geranium, zinnia, chrysanthemum and delphinium dried well in silica gel in 36 to 48 hours (Smith, 1993). Dahiya *et al.* (2003) reported that the best quality dried flowers of chrysanthemum could be obtained by embedding them in silica gel. Dhatt *et al.* (2007) studied the drying methods of rose buds and found that silica gel embedding of rose buds had the best quality with respect to colour and shape. Rengasamy *et al*. (1999) reported that sand, borax, alum, silica gel, yellow corn meal and combination of these could be used as desiccants. The desiccants can be re-used provided they are free from any particle of dried flowers and thoroughly dried. Paul and Shylla (2002) observed that both borax and alum were best suited for delicate flowers such as anemone, cosmos, larkspur and ornithogalium *etc.*

Microwave drying

Microwave drying is the quickest method of 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). Safeena (2005) reported that microwave drying for 2.5 minutes in Dutch rose cultivars maintained the quality of flowers. Microwave oven dried flowers looked fresh and more colourful than obtained by other methods (White *et al*., 2002). Embedded flowers and foliage in silica gel contained in non-metallic earthenware or glassware are kept as such in oven for a few minutes to induce effective drying (Bhutani, 1995). Arvinda and Jayanthi (2004) observed that best quality dry flowers of chrysanthemum were obtained by microwave oven drying with powdered silica gel as embedding medium when flowers were dried at 80 per cent micro power level for 120 seconds. After drying in microwave-oven, flowers must be left in the drying agent for a few hours for good colour and appearance. Dhatt *et al.* (2007) found that microwave drying of rose buds for 4 minutes exhibited good colour and good shape retention as compared to the drying for 3 minutes and 5 minutes, respectively. Microwave oven drying for cluster of florets such as golden rod, gypsophilla and corn flower is more suitable than others (Thomler, 1997).

Hot air oven drying

Prasad *et al.* (1997) observed that fully opened flowers were not suitable for oven drying. Oven drying of china aster flowers using white sand as the medium was the best for

retention of original colour, shape and texture of dried flowers (Raju and Jayanthi, 2002). Helichrysum flowers dried in oven for 48 hours retained good colour and shape for 150 to 180 days (Venugopal and Patil, 2000). Datta and Roy (2011) reported that different flowers take different time to dehydrate in hot air oven *viz*., Acroclinum, aster, bougainvillea, candytuft, French marigold, zinnia (48 hours), ixora (36 hours), small chrysanthemum flower (45-48 hours), pompon type dahlia, African marigold, narcissus, zinnia (72 hours), nymphaea (120 hours) at 40-45°C. Safeena *et al.* (2006b) studied the response of drying roses in hot air oven and concluded that silica gel drying in hot air oven at 40°C resulted in the best quality flowers. Singh *et al*. (2002) reported minimum degradation of zinnia flower pigments (chlorophyll, carotenes, xanthophylls and anthocyanins) in room dried flowers, whereas, it was maximum at 50°C in hot air.

Freeze drying

In freeze drying, flowers are placed into a refrigerated chamber and the temperature of the chamber is lowered below freezing. After that a vacuum is created in the chamber, causing the moisture in the flowers to sublimate, or change from solid to gaseous form. The water vapour is then collected in a separate chamber and the dried flowers are allowed to slowly warm to room temperature. This process may take several days (Trinklein, 2010). Brown (1999) studied freeze drying methods in different varieties of rose and carnation and found out the freezing time and temperature at which drying was perfect to keep the quality of flowers. Chen *et al.* (2000) conducted an experiment on effect of different freezing time (2 and 4 hours), freezing temperature (-35°C) and vacuum drying temperature (-27°C, -37°C, -47°C) on colour, moisture content, stem and petal of rose and carnation and concluded that lower vacuum drying temperatures resulted in flowers with colour closer to fresh flowers. Behera (2009) reported that maximum moisture loss and maximum total sugar content was obtained in the flowers which were dried in freeze drier. Several cultivars of carnation flowers were successfully cryo dried and remained naturalistic in appearance after being placed in freeze drier (-20°C) for 7 days (Bhattacharjee and De, 2003).

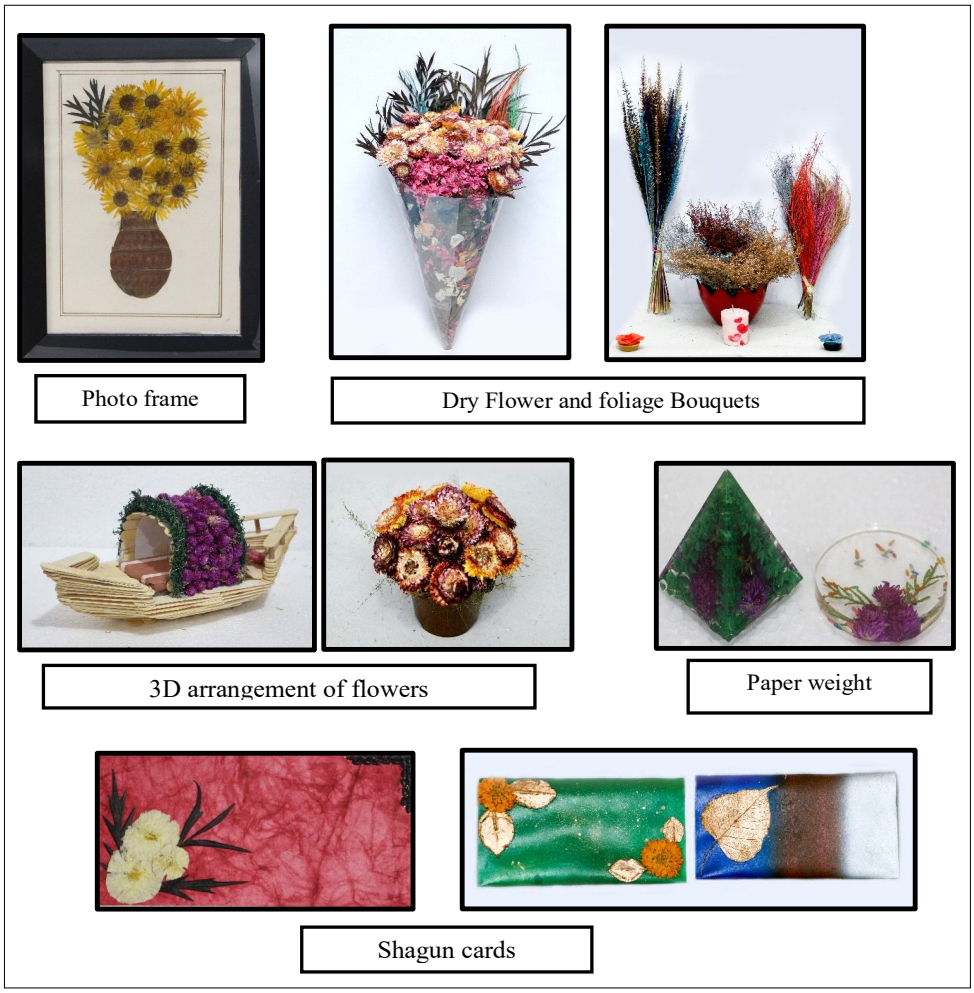


Fig 1: Dry flower products prepared at Value Addition Laboratory, SGT University.

Glycerine drying

Glycerine drying is most suitable for foliage preservation due to its osmotic nature (Harten, 2002), therefore, the foliage thus preserved and retain flexibility, shape and texture (White *et al.,* 2007) and can be used widely in preparation of many value-added products. In glycerine drying, the quality of the product was good as moisture in flower was replaced by a mixture of water and glycerine (Paul and Shylla, 2002). Singh *et al.* (2018) reported that the method of glycerinization for preserving foliage like asparagus, fern, cordyline and silver oak was found suitable. Prasad *et al.* (1997) opined that glycerine served as a good source for micro-organisms, so a pinch of antibiotic was necessary to prevent microbial growth in the dried specimens.

Bleaching and dyeing

Bleaching refers to removal or reducing the colour mainly using oxidative chemicals. Bleached ornamental plant provides a striking contrast when arranged with dried or dyed flowers. Bleaching also allows the use of dyes for colouring. Oxidative (Hypochlorite, Chlorite and Peroxide) and reductive (Sulphite and Borohydride) agents 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.

Colouring of dried flowers and ornamentals is known as dyeing. The bleached flowers and ornamental plant material can be made into colourful product by use of dyes. Dyeing enhances beauty as well as shelf life of the dried planting material. A dye is often added to the glycerine preserving solution to permanently colour the decorative plant materials.

Techniques for utilization of dry flowers and other parts

Dried flower arrangement is an art to enhance the beauty of the interior, keeping quality of the products and also gives the employment to the rural people. Dry flowers may be arranged in dry vases just as a fresh cut flowers arrangement. The dried flower products can be used with fresh flowers or alone in developing various floral arrangements. They may be arranged in bouquets or wall displays after fastening them to decorative bands. Pressed flowers, flower petals and leaves may be used in making number of products like greeting cards, book marks, wall sceneries, paper weights, table mats, *etc* (Fig 1). Dry pods, seeds, nuts dried fruits, flower skeletons can be used for decoration and various arrangements after giving some artistic touch.

CONCLUSION

The demand for dry flowers and their products is increasing day by day due to change in purchasing power and living habit of the human being. There is a large potential to develop dry flower industry in India for employment generation as industry is labour intensive. For expanding business, lucrative returns and limited competition, more and more entrepreneurs are expected to enter this blooming business in near future. Dry flower industry has unlimited prospect and only with sustained efforts, India can make a significant presence in the world market.

Conflict of interest

All authors declare that they have no conflicts of interest.

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