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Ranchana P
Assistant Professor, Department of Agriculture, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India

Bharanidharan A
Student, Department of Agriculture, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India

Irine Chacko
Student, Department of Agriculture, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India

Kanimozhi E
Student, Department of Agriculture, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India

Samyuktha C
Student, Department of Agriculture, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India

Lourdhu Shilani R
Student, Department of Agriculture, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India

Elizabeth Benny
Student, Department of Agriculture, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India

Sreenitha KS
Student, Department of Agriculture, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India

Senthilkumar GA
Student, Department of Agriculture, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India

Corresponding Author:
Ranchana P
Assistant Professor, Department of Agriculture, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India

Dry flower technology: A boon for the craft makers

Ranchana P, Bharanidharan A, Irine Chacko, Kanimozhi E, Samyuktha C, Lourdhu Shilani R, Elizabeth Benny, Sreenitha KS and Senthilkumar GA

Abstract
Dry flowers and related plant products have attained colossal prospective as stopgap for fresh flowers and foliage for interior scaping and for other diversified fascinated and saleable products as well. They have conquered paramount significance in the floriculture trade with an expanding discernment on environmentally-sound handiworks, innumerable ameliorated products can be manufactured from dried flowers viz., picture postcard, wrappers, pomanders, festive decorations, bouquets and wreaths, potpourri, collages, flower pictures, flower balls, etc. Dry flower trade shares 71% of total floriculture export in our country. In the present paper all the slap dashed details and particulars are being amassed which would be beneficial for further research and learning process. It will limelight the one who is willing to start the dry flower business and for the researchers, green panthers and environmentalists as well.

Keywords: Dry flowers, drying techniques, floral handicrafts, value added products

Introduction
Flowers occupies a supreme position in Indian's history as an integral part of day-to-day life. Fresh flowers are very attractive and possess fragrance which is used for hair adornments and floral ornaments, etc. At the same time, they are seasonal, short-lived and fetch high prices in the market. Dry flowers act as an alternative source of fresh flowers in terms of flower arrangements, interior decorations, eco-friendly and cost-effective. They also stand good for a long period. Hence, it attained a prime importance in floriculture business throughout the world. They complement any home decor in both formal and informal arrangements. It attracted the public to use dry flowers as an aesthetic, long-lasting, environment safe and biodegradable products as a pinch hitter for fresh flowers and products for indoor decorations (Datta and Roy, 2011) [19]. Dry flowers and products contribute a share of more than two-third part of all the floricultural products exported from our country. India exports the dry flowers and products to various countries *viz.*, USA, Europe, Japan, Australia, far East and Russia. Potpourri, a value-added product of dry flower had attained a principal product of export in our country which only accounts to Rs.55 crores in dry flower export (Arul Murugan *et al*., 2007) [63]. This lucrative business was acquainted in India by British settlers in Calcutta. They have chosen this zone because of its proximity to north east and eastern zones. Moreover, it is known for the ample existence of exotic and diversified plants (Bhattacharjee and De, 2003) [7]. Any parts of the plant materials (leaves, stems, bark, flower, fruit, seed, root, etc) can be used for dry flower making with a condition that it should be in a dried state. One can use the natural dried materials or go for artificial drying (Patricia *et al*., 2003) [34]. Several methods of drying are available for plant species *viz.*, sun drying, air drying, oven drying, drying using desiccants, microwave oven drying, freeze drying, press drying and glycerinization treatment. These treatments help to dry the plant materials and provide the raw materials for the preparation of home décor products in an aesthetic way. Dyeing of ornamental materials may be considered as much as an art as a science. Hence, the dry flower industry is a remunerative business which provides self-employment and job opportunities and is eco-friendly and biodegradable as well.

Collection of plant materials
Rabirah Awang (2002) [36] stated that the flowers chosen for drying should have aesthetic value and be picked at the right time. It should be healthy and undamaged. Sue Spielberg (2002) [49] suggested that the flowers should be harvested on dry sunny days.

Most of them can be picked as their blooms start to open, but particular care should be taken with Helichrysum, whose flowers will disintegrate in storage if they are picked too late. For air drying, the leaves should be removed prior to drying. Trinklein (2000) [54] suggested that usage of plant parts or flowers free from insect and disease attack found suitable for drying. According to Lourdusamy (2002) [28], full bloom for gomphrena, both half bloom as well as full bloom stage for French marigold (*Tagetes* spp.) and zinnia (*Zinnia* spp.) are the ideal stages for dry flower production. Bhattacharjee and De (2003) [7] found that half bloom and full bloom stages of chrysanthemum, rose and celosia are best suited for drying purpose when such flowers were harvested at the beginning of maturity, while other flowers on the stem or plant may still be partially closed, the blooms will open more as they dry. The best time to pick flowers for drying is mid-morning when the dew has dried but before they were wilted by heat and sun (Anon., 2003) [2]. The drying method does not influence the drying of flowers and it mostly depends upon the harvesting time. The flowers should be harvested before they attain their full bloom stage (Bale, 2006) [6].

Dehydration Techniques

Sun drying

Drying of plant materials by embedding in the sand is termed as sand drying. To get the best results, the medium is allowed to expose under hot sun every day. Most of the traditional flowers available in our country are dried by this method. In the sand. The flowers are dried under open sun by placing them in upside down manner for one or two days (Arul Murugan *et al*., 2007) [63]. Lourdusamy *et al.* (2002) [28] reported that flowers like small zinnias (*Zinnia* spp.), marigold (*Tagetes* spp.), pansies (*Viola* spp.) and chrysanthemum (*Dendranthema* spp.) embedded in sand in an upside-down fashion and kept in the sun and it was dried in 2 days. The traditional flowers *viz.*, *Gomphrena*, Zinnia and French marigold took 3-4 days for sun drying. According to Arul Murugan *et al*. (2007) [63] flowers like small zinnias (*Zinnia* spp.), marigolds (*Tagetes* spp.), pansies (*Viola* spp.) and pompon chrysanthemum (*Dendranthema* spp.) embedded in sand in an upside-down fashion and kept in the sun would dry in a day or two. Compact blooms like zinnia were suitable for sand drying (Singh and Kumar, 2008) [47]. Sand can be used to dry wide variety of flowers such as roses (*Rosa* spp.), tulips, dahlias (*Dahlia* spp.), marigold (*Tagetes* spp.) and snapdragons (*Antirhinum* spp.). Flowers which last only one day like lilies (*Lilium* spp.) did not dry well. Asteraceae flowers (ex. Daisy) should be dried face down. Snapdragons (*Antirhinum* spp.), lilac (*Syringa* spp.), elongated flowers and flowering branches should be positioned horizontally and flowering branches faced up. Roses (*Rosa* spp.), peonies (*Paeonia* spp.) and tulips (*Tulipa* spp.) should be dried face up (Braun, 2009) [12]. Narayana (2011) [33] reported that rose (*Rosa* sp), chrysanthemum (*Dendranthema* spp.), gomphrena (*Gomphrena globosa*), alstroemeria (*Alstroemeria* spp.), snapdragon (*Antirrhinum* spp.), statice (*Limonium* spp.), helichrysum (*Helichrysum* spp.), orchid (*Dendrobium* spp.), celosia (*Celosia* spp.), carnation (*Dianthus* spp.), cup & saucer (*Holmskioldia sanguinea*) and cone flowers (*Echinacea purpurea*) are suitable for different drying methods. Among the different methods attempted for drying, shade drying was found to be better in respect to flower colour. Sand was found better with respect to retention of better shape and size of the flower.

Air drying

Air drying is the cheapest and simplest method of drying in which flowers are hanged for drying. Well-conditioned, underdeveloped flowers are chosen for drying. Individual specimens are dried in a drying rack (an old window screen works fine) or flowers are tied in loose bunches with rubber bands or twist-ties and hang upside down in a cool, dry, well-ventilated dark room. Large flower heads should be hung individually. Flowers take up to 1-2 weeks for drying and it depends upon the surrounding moisture content, humidity and temperature. It is one of the best methods which takes a short time and yields scrumptious results. The material should not be placed in a warm oven or in front of electric heaters to speed up the process, because this can be dangerous. Some air circulation is necessary to prevent growth of mould and to allow proper drying (Shaiza Rana, 2018) [43]. Harten (2002) [28] reported that calendula (*Calendula officinalis*), callistemon (*Callistemon* spp.), celosia (*Celosia* spp.), digitalis (*Digitalis purpurea*), baby's breath (*Gypsophila* spp.), straw Flower (*Helichrysum* spp.) were suitable for air drying. Smith (2003) [47] found that the yarrow (*Achillea* spp.), amaranth (*Amaranthus* spp.), strawflower (*Helichrysum* spp.), cornflower (*Centaurea* spp.) and lavender (*Lavendula* spp.) are suitable for air drying. Maria *et al.* (2003) [30] revealed that air drying at ambient temperature produced fewer changes in aroma of parsley than the other drying methods like oven drying and freeze drying. Air drying was the most simple and cheap method as it depends upon atmospheric humidity, air velocity, moisture content of the flower, type and size of the flower (Datta, 2004) [18]. This method is found to be highly suitable for drying brittle type flowers like rumex, delphinium, anaphilis, holmskioldia and oregano etc can also be dried by air drying (Deshraj 2006) [21]. Singh and Kumar (2008) [47] reported that chinese lanterns (*Physalis* spp.), baby's breath (*Gypsophila* spp.), poppy seed-heads and globe thistles (*Sphaeanthus indicus*) were dried for three weeks. Frogge (2009) [26] said that air drying was mostly suitable for annuals like globe amaranth (*Gomphrena globosa*), statice (*Limonium* spp.), straw flower (*Helichrysum* spp.), perennials like chrysanthemum (*Dendranthema* spp.), baby's breath (*Gypsophila* spp.), rose (*Rosa* spp.), biennials like money plant (*Epipremnum aureum*), goldenrod (*Solidago* spp.), Indian grass etc. Simple air-drying was very effective for hydrangeas. They do not retain the natural pink or blue colours after drying (Wayne, 2010) [59].

Oven drying

Oven drying (hot air and microwave ovens) is the fastest drying method which improves the quality of dry flower products. Plant material is placed at controlled temperature for a specified time and is different for plant species. Temperature imparts a vital role in the drying of flowers and other ornamental plant parts by determining either qualitative and quantitative parameters. In hot air oven drying, flowers are dried in a convection chamber, it has a fan inside. For drying, temperature should maintain between 30 to 35°C. This technique takes a few hours to several days to dehydrate the flowers. Flowers are kept in grooves in a wire mesh. Time taken for drying depends upon the number of flowers dried at one time within the chamber. Otherwise, microwave drying is a very fast method for drying which generates less amount of

heat. In this technique, moisture is liberated with the help of a microwave by agitating water particles in organic substances. For drying it takes 5-10 minutes in the microwave. The flowers are taken out as soon as the process is getting over and placed in the room temperature for a stipulated period of time which allows full dehydration of plant materials by evaporating the remaining moiture in it. This process is known as setting the time which varies from species to species (Mayak and Halevy, 1980) [31]. Diane (2000) [22] reported that fresh coloured leaves can be dried in a microwave oven. It took 30 seconds to three minutes for drying depending on the leaf and moisture content. Saxena (2001) [43] observed that chrysanthemum when embedded in sand and dried in a hot air oven at 40 °C for 5- 40 hours gave the best result. There is no change in colour and structure of flowers. Sukhmani *et al.*, (2002) [50] revealed that silica gel embedding was considered to be the best method for drying of rose (64 hrs), helichrysum (36 hrs) and foliage like ferns (30 hrs), silver oak (36 hrs). Microwave oven drying proved to be the best for asparagus (1.30 minutes). Singh *et al.* (2002) [46] observed that pigment degradation resulted with increase in temperature in hot air oven drying. Foliage of woody species was more tolerant to dehydration than foliage of herbaceous species (Robert *et al.*, 2003) [37]. Sangama (2004) [41] reported that among the different colours of helichrysum, yellow-coloured ones obtained maximum score (5) with sand embedded in the hot air oven and minimum score (1.2) was obtained when not embedded. Dubois and Joyce (2005) [25] reported that one way of increasing the drying rate was to raise the air temperature. The best temperature range for drying plants was between 60 °C and 80 °C. If the temperature is greater than 60 °C, the enzymes which catalyse the reactions within the plant tissue will be destroyed. This is desirable because some enzymes were responsible for chemical reactions which result in browning (eg: polyphenol oxidase). Bhalla *et al.* (2006) [9] reported that in chrysanthemum minimum size reduction and maximum carotene content was obtained when flowers were embedded in silica gel and dried at 30 °C for 24 hours in a hot air oven and 30 seconds in a microwave oven. Singh and Kumar (2008) [47] revealed that thick petal flowers were unsuitable for microwave oven drying *viz*. Marigold (*Tagetes* spp.), zinnia (*Zinnia* spp.), corn flower (*Centaurea cyanus*), and chrysanthemum (*Dendranthema* spp.). In zinnia, flower size and colour remained unaltered in sand and silica gel embedding after dehydration using an electric and microwave oven (Misra *et al.*, 2009) [31]. Fresh African and French marigold can be embedded in sand and silica gel and dried in hot air oven for 48 hours at a temperature of 40 – 45 °C were utilized for making value added products (Banerji and Dwivedi, 2010) [7]

Embedded drying/ Desiccant drying

This technique is predominantly helpful to dry subtle flowers which often get damaged or distorted under air drying methods. Embedded drying is an ideal technique over oven or air-drying methods and it diminishes the petal contractions in the end products. This technique absorbs the moisture content completely by the usage of desiccant materials. The desiccants which are commonly used are borax, silica gel, sand, expanded clay, kitty litter, perlite, dry sawdust, and corn-starch etc for drying plant materials and ornamentals. By using this, desiccants moisture is removed very fast from the flowers than the air-drying method and besides that maintain the flowers in natural form. The common river sand which is available at the seashore is termed as white sand. Though it is easily handled and available, used for embedding. Silica gel is identified as the best desiccant to dry the flowers with colour, shape retention and also does not cause any shrinkage or brittleness and also bleaches the materials if stored for a long time. It has aerogel of silicic acid that is why it is called a gel and it has granular shape. For removing moisture from flowers, silica gel (60-120 mesh) is known as the best absorbent (Shaiza Rana, 2018) [43]. For rapid drying of flowers, pure borax is used but it leads to burning or bleaching of the flower parts exclusively for delicate flowers. Besides, it can be used with white or yellow corn meal as a milder drying agent. This combination is found to be suitable for subtle flowers when used with utmost care and attention. For rapid drying of flowers borax and cornmeal is used in the ratio of 1:1 and at the same time the same combination in 1:3 ratio should suffice for slow drying. While adding salt (one tablespoon) favours the speedy drying process. Among the desiccants, silica gel showed quicker results than borax and sand. Borax caused fading of colour and rough texture of petals. The flower quality was very well when by embedding it dried in silica gel and sand (Singh and Dhaduk, 2003) [44]. Singh and Kumar (2008) [47] reported that the desiccant drying was suitable for more dimensional flowers like rose (*Rosa* spp.), carnation (*Dianthus* spp.), marigold (*Tagetes* spp.), lilies (*Lilium* spp.) and dahlias (*Dahlias* spp.). According to Trinklein (2010) [56], flowers embedded in silica gel dry quickly and he found that the drying time was 2-3 days for baby's breath, 2-3 days for cosmos, 3-4 days for marigold and 2-3 days for pansy. Flowers *viz.*, Roses (*Rosa* spp.), pansies (*Viola* spp.), daisies (*Bellis perennis*), peonies (*Paeonia* spp.), larkspur (*Delphinum* spp.), grasses, carnations (*Dianthus* spp.), bachelor buttons (*Gomphrena globosa*), zinnia (*Zinnia* spp.) are suitable for drying using silica gel (Cary, 2011) [13]. Roberts (2011) [38] reported that air drying, glycerine drying and pressing were good for smaller flowers. For larger flowers with blooms that were fragile, it is better to dry using desiccants. Desiccants are substances that absorb moisture. A good desiccant is silica gel which has quick drying time and maintains the color and texture of flowers.

Freeze drying

The plants and flowers dried in this technique will retain the most natural-looking preserved materials. However, this approach entails specialized and expensive equipment. It depends on the principle of sublimation, whereby ice held under circumstances of low temperature (less than 0 °C) and partial vacuum (less than 4.58 torr) will evaporate on heating without going through a liquid phase. Dubois and Joyce (1989) [23] stated that undesirable chemical reactions will not occur under the condition of absence of liquid water during the dehydration process. Henceforth, colour and even fragrance are retained in the dried materials. In this process, the flowers are placed into a refrigerated chamber and the temperature of the chamber is reduced below freezing. A vacuum is then created in the chamber, causing the moisture in the flowers to sublimate, or change from solid to gaseous state. Water vapour generated during this process will be collected in a separate compartment and the flowers which are dried in this technique are permitted to gradually warm to room temperature. This process takes several days (Trinklein

2006) [53]. Chen Wei *et al.* (2000) [14] reported low moisture content at higher vaccum drying temperature in flower drying of rose and carnation. Bhattacharjee and De (2003) [7] reported that numerous cultivars of carnation flowers were effectively cryo dried and endured naturalistic appearance after being placed in freeze drier (-20ºC) for 7 days. Dubois and Joyce (2005) [25] indicated that the colour and fragrance were maintained in the dried material after freeze drying and also there is no contraction or alteration during the drying process. Freeze dried flowers were fresh flowers that have been specially dried to reserve their natural form, colour and attractiveness. Roses took 15–17 days and for other flowers it normally took 10 -12 days. Major flowers dried by this method are roses, carnations etc. (Murugan *et al*., 2007) [63]. Behera (2009) [8] conducted an experiment using lyophilizer for drying flower samples. In this experiment, the temperature of the flower chamber of the freeze drier was increased from -5°F to 25°F with an interval of 5°F each. He observed that maximum moisture loss and total sugars content was resulted in the freeze-dried flowers.

Press drying

The most common method for the preservation of flowers and foliage is to put them under pressure by keeping the material in blotting paper, newspaper, old notebook paper, exaggerated imbrications of plant parts. The pressure can be applied by various ways such as with the help of plant press, the plant press is an equipment which is particularly designed for the botanists to compress the plant samples, it is composed of two strong panels the outer and inner board provided with strips or bolts that can be tightened around them to exert pressure, besides this press drying can be done by keeping the blotting paper containing plant material in between the heavy books. For drying it takes up to 3-4 weeks because it depends upon the water content of tissue in flowers. Time period should be condensed if flower pleated sheets is put in oven at suitable temperature. Gouin (1994) [26] reported that press drying is the most common method used for preserving fragile flowers as well as summer and fallen foliage. Bhutani (1990) [11] observed that pressed flower of snow bush (*Euphorbia leucocephala*), lantana (*Lantana camara*), larkspur (*Delphinium* spp.) and ixora (*Ixora* spp.) took 24 hours at 40 °C – 44 °C for drying after pressing them for 24 hours at room temperature. Fresh flowers and leaves were placed between folds of blotting sheets and kept one above the other. Corrugated boards of the same size were placed in between folds to allow water vapour to escape. The plant press had to be tightened regularly. This process takes 1 to 3 months for drying (Rothenberger, 1997) [38]. Heat pressing is an easy way to preserve leaves when leaves are placed between two pieces of waxed paper and pressed with a warm iron. New pieces of waxed paper were used for each pressing (Anon., 2004) [3]. Newspapers, old telephone directories or catalogues were suitable for press drying (Trinklein, 2008) [55]. Singh and Kumar (2008) [47] reported that flowers *viz.* pansies (*Viola* spp.), aster (*Aster* spp.), cosmos (*Cosmos* spp.) and zinnias (*Zinnia* spp.) were suitable for press drying. Ferns are also more suitable for this method.

Glycerine drying

In this method, a solution of glycerin and water is used to systemically preserve decorative foliage which yields a final product that is soft and pliable and remains so for several years. This process replaces some of the water in fresh plant tissue with glycerin. When the resultant product is air dried, water remains in the plant tissues and evaporated, remnants of glycerine may act as a lubricant in keeping the plant soft and pliable. Viburnums (*Viburnum* spp.), magnolia (*Magnolia* spp.), juniper (*Juniperus* spp.), gardenia (*Gardenia* spp.), box wood (*Buxus* spp.) were most suitable for glycerine drying (Collier and Jett 1985). Harten (2002) [28] reported that evergreens can be preserved all the year round, as long as they were kept reasonably warm during preservation, but deciduous material can be preserved only during the end of June and mid-September and autumn fall. Foliage should always be mature when preserved. This Glycerinization technique was found more appropriate for foliage than flowers. Even flowers which possesses "bracts" (modified leaves) such as Hydrangea and *Molucella laevis* (Bells of Ireland) can also dry well in this method. The average time for glycerine drying was 2-3 weeks. For best results, this method was tried during the summer months when absorption is more rapid. White *et al.* (2007) [60, 61] reported that treating foliage with glycerine yielded unique results. Although stem and leaves turned brown in this process, they remained flexible and pliable indefinitely. He also reported that average time taken for uptake treatment was 2-3 weeks and this is highly suitable for foliage of magnolia (*Magnolia* spp.), ligustrum (*Ligustrum* spp.) and broad-leaved evergreens. In full dip method, the plant material absorbed glycerine through the leaf surface when submerged in the solution. This is applicable to ferns and single leaves of poplar and palmetto. Singh and Kumar (2008) [47] revealed that glycerine drying was suitable for leaves and pods. The material would take about 2–3 weeks to dry. Susan (2009) [50] reported that 1 part of glycerine mixed with 2 parts of hot water was the suitable mixture for twigs to absorb glycerine at room temperature. In glycerine drying the woody stem foliage was cut and the stem ends were split and then placed in the glycerine solution immediately. For calyces, seed heads, herbaceous foliage and soft stemmed leaves the mixture was first allowed to cool and then allowed to stand in the container in a warm, dry, dark place (Paula, 2010) [34]. He also reported that glycerine method of drying was recommended mainly for foliage as it gave the materials more flexibility and she had suggested that Camellia (*Camellia reticulata*), silver oak (*Grevillea robusta*), emu bush (*Podocarpus macrophyllus*), common bracken (*Pteridium aquilinum*) and thuja (*Thuja orientalis*) were suitable plant materials for glycerine method with low brittleness (0.50 to 1.21) and good overall acceptance. Cintu (2010) reported that glycerine full dip method was found to be the best treatment for all quality parameters in camellia, thuja, silver oak followed by glycerine uptake method. Drying plant materials with glycerine make them pliable and retain their natural shape. Glycerine drying is recommended for leaves and berries. Leaves of camellia (*Camellia* spp.), ivy (*Hedera helix*), maidenhair fern (*Adiantum venustum*) and eucalyptus (*Eucalyptus* spp.) were good for drying with glycerine (Anon., 2011) [5].

Water drying

Some flowers dry well if placed in water. The flower stalks are placed primarily in two inches of water and water is allowed to be taken by the cut flowers or to evaporate. The vase/ container and flowers should be kept in a dry, warm and dusky location. Hydrangeas, yarrow, bells-of-Ireland and

celosia dry well with this method. Anon. (2001) [1] suggested that hydrangea, gypsophila and *Alchemilla mollis* should be picked and placed upright in position in a vase with an inch of water in the bottom, by the time the flowers have used all the water they have dried successfully. Deepthi and Santhosh (2008) [20] reported that yarrow, hydrangeas, bells of Ireland, ageratums, alliums, acacia, celosia and Gypsophila do well with water drying.

Dyeing

Dyes are organic compounds which absorb light of 205-900n multra frequencies, thus only reflecting a portion of the visible spectrum with the result that the eye sees colour. Each pure dye compound therefore has a unique colour. The vast number of different colours are available as the result of blending pure dye stuff. To dye the dried plant parts, Tampion and Reynolds (1971) [51] suggested the use of culinary dyes which are often used to colour icing sugar, owing to their wide range of available colours and non-toxicity to plants. William and Seagal (1972) [61] gave a detailed account of various categories of dyes. They also furnished that there has been significant development in organic colour chemistry. The first even dye was discovered in 1856, the dye was named as perkins violet and following this, many colours were found out such as indigosol, fire red, hansa yellow colour, sulfar black *etc.* And also reported that the basic dyes were the first of the synthetic type to be made out of coal tar derivatives. Although basic dyes produce brilliant colours. They have poor fastness to light smudge off easily. Sambandamurthi and Appavu (1980) [40] reported that Ammonium purpurate gives rhodonite red colour to the flowers and eosin gives scarlet colour. Dana and Lerner (2002) [7] and White (2007) [60, 61] reported that fragile flowers should be dyed before drying especially if dried with a dessicant, also reported three types of dyeing *viz*, dip dyeing (grasses), spray dyeing (heavy textured materials like pods, cones seeds), absorption dyeing (fresh leaves with glycerine medium) and White (2007) [60, 61] reported that spray heavy textured materials with lacquer or varnish to add a shine or permanent finish. Dam *et al.* (2002) [16] reported that in general, the dyeing performance of basic dyes on coir is better than acid or direct dyes. Dam *et al.* (2002) [16] reported that direct dyes are applied by boiling the fibre material and gradually adding salt, which promotes adsorption on to the fibre. The affinity of the dyes is affected by salt concentrations (ionic strength) temperature, pH and fibre surface (a feature that can be altered with pre-treatment) and also reported that dyeing with food-approved dyes has been suggested, but this will require suitable methods of fixation, which may be achievable by converting them into reactive dyes. Vinod Kumar *et al.* (2003) [56] reported that tuberose spikes which were pulsed with ammonium purpurate (0.1%) for 5 hrs and with bromocresol green (0.1%) for 5 hrs losts entire colour after 48 hrs of vase life. Wang *et al.* (2004) [57] reported that Crosslinking polymeric dyes exhibited outstanding fixation of 99%; disperse polymeric dyes presented first-rate light fastness (8 grade); "fiber-reactive" polymeric colorants could form a chemical covalent bond with fiber, exhibited excellent washing fastness; acidic polymeric dyes showed the same fastness properties as the corresponding monomeric dyes, furthermore thermal stability was enhanced. Zaman *et al.* (2001) [62] carried out research on optimization of jute fiber dyeing with reactive dyes and mordant dye stuff with few external influences. Samanta (2007) [40] reported that cotton fabric dyed with reactive yellow exhibits better results than the fabric dyed with reactive red 6B due to higher fixation ability. Deepthi and Santhosh (2008) [20] reported that procion type colours are best for dry flowers and for very soft flowers add Magnesium chloride to enhance the colours. Anon. (2010) [4] stated that acid dye class is a water-soluble class of dyes with anionic properties. The textile acid dyes are functional for protein fibers such as silk, wool, nylon and modified acrylics. Acid dyes are fixed to the fibers by hydrogen bonding, vander waels forces and ionic linkages. The dyeing is generally carried out at boiling temperature for 30 - 60 minutes depending upon the depth of the shade and dyestuffs used and also stated that the wet and light fastness properties of the acid dyes vary from poor to excellent, depending upon the molecular structure of the dyes. Since these dyes have very good levelling and migration properties, and have a low affinity for the fibre, therefore the wet fastness properties of this class are generally poor.

Dry flower products

Potpourri is usually a combination of dehydrated, sweet-scented plant portions with flowers, leaves, seeds, stems and roots. The source of a potpourri is the aromatic oils originated within the plant. It is of two types *viz.*, dry and moist. The dry method is the most common, quicker and easier method but the disadvantage is it does not last for a long period. Both methods Fixative is needed for both methods for absorbing the aromatic oils and to release them slowly. The aromatic herbs used for perfumery such as Rosemary, Sage, Lavender, Artemisia, Thyme, Basil, Achillea (Yarrow), Scented Geranium, Mint, Marjoram, Verbena, Anise and Fennel. While drying the herbs and fruits, it should be thoroughly dried. Otherwise, it invites the problem of preventing mildew. Dry and pressed flowers can be used for preparing home decor products. They can be utilised in the best manner for creating decorative wall hangings, greeting cards and covers, floral craft items, floral designs, floral balls, festive decorations, calendars, and other creative exhibits. Floral albums may be prepared with dry flower items for identification of plants for botanical studies. A small-scale or cottage industry based on dry flower home décor products using dehydrated flowers, leaves, fruits, pods, seeds and other plant parts in a discrete possibility. Dry flower products may be arranged aesthetically and covered with plastic or transparent glass to protect them from wind, atmospheric humidity and dust. Dehydrated products closed in glass containers may be used for interior decoration. To get the benefit of value addition, the dry flower industry can be associated with many secondary industries like terracotta, packaging, cane, basket, cotton fabrics, glass, jute, iron and brass, ribbons and laces, candles etc. by combining one with the other to have the benefit of value addition.

Conclusion

Dry flower technology is a boon to generate self-employment especially those who have creative ideas and artistic skills towards making home décor products which fetch high price in the market. Because, it is made up of natural plant-based materials. It is an effective, potential post-harvest technology for improving the ornamental keeping quality of flower and plant parts. India is bestowed with natural resources of rich

flora which offers a great scope for this dry flower industry. It also paves a way to create a small-scale industry by engaging housewives, unemployed youths, etc. It assures high quality of the various decorative products from a functional, physical, and sensorial point of view at the lowest possible energy consumption. It not only creates a route for ornamental products making but also contributes to earn more foreign exchange. Though, it attained positive sides, some void is also noticed pertaining to the delicateness of the produce, hygroscopic nature, dearth in packaging techniques to store it in a long run, which prerequisite intensive research towards strengthening the techniques in above aspects to accomplish the best ever home décor products.

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