Chapter 2

Literature Review
2.0 Literature Review

Different methods for preserving plant materials have been tried by various workers to retain their natural colour and form for a very long period. One of the earliest surviving botanical collections dates back to 1569 and is curated by the Naturkunde museum in Ottonum, Kassel, Germany (Reid, Gordon 1994). In this field only a scandy in formation are available in the form of published research works. However the available information from various sources complied as follows. The information collected on this topic can be divided into different sub-topics. These sub-topics include Wet Preservation, Dry Preservation; Desiccant drying, Plastic infiltration, Plastic embedding, Glycerine drying, Air drying, Oven drying, Freeze drying, Microwave drying and so on. There are few notable scientists who have been worked seriously on the colour preservation. Others have been worked for different reason including some as hobbyist.

2.1 Wet Preservation

In 1838, Cleghorn suggested presenting the plant specimen with colour in a saturated solution of common salt in water. The specimens preserve intact only few months by this method moreover the traces of salt get deposited as dirt on the inner sides of the container. Mr. C.E. Jones (July, 1917) have been preserved green foliage and plants by boiling in a solution of copper
Acetate and acetic acid. This method also described by Jones in the Museums Journal, 1917. Butler, O. (1918) suggested adding Citric acid to 1% solution of Sodium bisulphate in which the given specimen has been kept immersed, till a strong odour of Sulphur dioxide is given off. Further the specimen was transferred to a 4% Formalin. This method has been found satisfactory for the preservation of red-brown pigments in specimens. The result was however not satisfactory as far as the preservation of the green colour is concerned. Maltby, (1926) has been recommended a number of methods for preserving different types of plant parts with colour retention. For preserving green part of plant, he also suggested, to keep the specimen in a solution of Copper sulphate and bubbling in Sulphur dioxide gas. Further he suggested to boil the plant material for a few minutes in a dilute solution of Copper acetate or Copper sulphate in Glacial acetic acid. Both methods required costly equipments, and offer a limited rate of success. Suggestions from Mackenzie (1928) comprises a number of formulae consists of Sulphurous acid, Formalin, Glycerine, Copper sulphate, Paraffin oil, etc. for preserving different plant parts, with particular attention to fruits. Her formulae vary with the plant parts, and are not suitable for preserving whole plants. Mackenzie shows the results of practical experience gained whilst preserving a comprehensive collection of hard and soft fruits, in natural colours, convenient for examination or demonstration. Mackenzie emphasised the need for individual treatment of most fruits of hard and soft and of different colours. The preservation of green foliage is a relatively simple matter; the colour is fixed by means of Copper sulphate, Sulphurous acid being used as an antiseptic both during and after preparation. For old, dark-green foliage, a stronger Copper solution is used
than for young tender light-green leaves. Owing to the simplicity of this method of preservation of leaves, it has been found more satisfactory to treat them separately from the fruit up to the storage stage, though in many cases it would be possible to treat leaves together with fruits. It was found that the Paraffin - Formalin method was very satisfactory for apples, and consistently successful results have been obtained by its use. For Pears, Quinces, and soft fruits, however, the somewhat easier Sulphurous acid and Formalin have been used with good results, except in the case of highly coloured Pears, upon which so far there has been no opportunity of carrying out a series of experiments. Attempts to preserve Apples by this latter method have not met with success. The failure may be due to differences of texture and consequent differences in rate of penetration. The fruits of different colour were preserved as Red Apples or Yellow Apples with Red stripes or Flush by one gallon Paraffin oil, 1 oz. Formalin. Change in three weeks to 1 gallon water and 2 oz. Sulphurous acid. For Green Apples with Red stripes or Flush, the same formulae as for the preceding may be used, with the difference, that Copper sulphate must be added to the stronger Sulphurous acid solution to restore the green colour which has disappeared in the Paraffin oil. Apples, Pears, Plums, Cherries, and small fruit, together with their foliage, have been successfully preserved by the use of various modifications of the Paraffin, the Sulphurous acid, the Formalin, and the Copper sulphate methods. Specimens thus preserved, when adequately mounted, have so far remained in satisfactory condition, without further attention, for three years. Adriano, F.T. and Yonzon, E. (July 1933) prepared solutions to preserve different colours of fruits and
vegetables. In case of green coloured specimen initially kept in fixing solution composed of Copper sulphate solution prepared by dissolving 500 grams per litre. After the Copper sulphate immersion, the material washed with clean water for several hours. Specimens then stored in storage solution consists of Distilled water to which Sulphur dioxide has been passed for about 15 or more minutes and sealed the jar. For yellow coloured specimens like Mango, Banana, Carrot etc. stored in the following solution without preliminary fixation. Distilled water 2,785 cc, Formalin 3.5 grams (1/8 oz.), Sulphurous acid - 6% 15 cc. (1/2 oz.), Boric acid 28 grams (1 oz.), Copper sulphate to give a faint green colour. After the immersion vessels sealed carefully. Aforesaid formula also used for white coloured specimens like Onion, Cucumber, Radish, Mushroom etc. Specimens of red colour or multicoloured like red Tomatoes, Chico, Strawberry, Red pepper etc. preserved by placing them immersed completely in the solution of 6% Sulphurous acid solution, 1 litre, Boric acid 2 - 4 grams, Formalin 5 - 20 cc. Another formula prepared by Cruess for this class of specimens is as follows: Distilled water 3,785 cc., Refined salt 56 grams (2 oz.), Formalin 7.5 cc. (1/4 oz.), Sulphurous acid 6% 4 cc. (1/8 oz.), Potassium nitrate 7 grams (1/4 oz.), Glycerine 270 cc. (8 oz.) They also recommended Cane sugar syrup (15 %) instead of Glycerine. All above formulae can only preserve specimens upto 8 to 12 months period. Scully (1937) developed some solutions that give satisfactory results for the colour of many flowers and fruits. In this method, place specimens in vials containing a 5 percent Copper sulphate solution for 24 hours to set the colour. Wash the specimens several times and put them into a second solution of 16
cubic centimetres of Sulphuric acid, 21 grams of Sodium sulphate, and 1000 cc. of water. The material is maintained in the solution in corked vials. According to Scully, delicate pinks and blues or some of the deep reds and purple colour will fade, whereas many of the colours, especially the yellow range, will show very little alteration. Blaydes (1937) suggests storage of specimens in a 0.2% solution of Copper sulphate in the standard Formalin-acete-alcohol. Johansen (1940) substitutes Propionic acid for acetic acid in the solution. The solution found unsatisfactory, since it discoloured by the Sulphate. Johansen (1940) also enumerates Conant's Hot Method, Conant's cold Pack Method and Keefe's Preserving Fluid, for preserving green plant parts with shape and colour. They require Acetic acid, Copper acetate, Formalin, Alcohol, etc. which increase the cost enormously. He has also suggested an easy and simple way of keeping the plant materials in a solution of Boric acid in Glycerine. However this solution the colour of the material lost after a few months. Chandrashekar, M.S. (1958) has suggested preserving the green plant specimen with colour. The procedure suggested, requires the employment of two solutions - solution A, saturated solution of Copper sulphate in 10% aqueous Formalin; and solution B, 5% aqueous Formalin. He prepared a 10% of solution of formalin in water and finely powdered Copper sulphate dropped little by little at prolonged intervals into the Formalin solution till a large quantity of the salt accumulates after the saturation point at room temperature. A freshly-collected whole plant of Scilla indica Beaker is kept immersed in the solution of Copper sulphate, mentioned above. The container is sealed and kept for seven days. Then the specimen is transferred
to a 5% formalin solution. In the final preservation fluid. Sometimes it turns slightly bluish green after few months. All that is necessary then, is to renew a fluid. After a couple of renewals, the solution remains colourless. They also preserved some other plants eg. *Allium cepa* Linn., *Raphanus sativus* Linn., *Solanum tuberosum* Linn., *Pongamia pinnata* Merr., *Vitis vinifera* Linn., *Bulbophyllum sp.*, and *Pectis popposa*. No deterioration has been noticed both in regard to the colour of the non-Chlorophyll bearing tissues, and in regard to the original turgidity of the specimens. Knudsen, (1972) reveals that when preserving huge quantities of specimens in small containers, increase the percentage of Formalin. Use of Formal-acetic alcohol (FAA) for preserving specimens intended for slide-making and histological studies, in the ratio of 93 parts of Formaldehyde to 3 parts of Glacial acetic acid. One of the drawbacks of liquid preservation is that some species become soft and many will lose their natural colouration, especially if they are exposed to light. Flowers, fruits, stems, leaves and other plant parts are preserved in a 4 percent Formalin solution and for large, fleshy specimens in 5 to 6 percent solution and specimens with waxy coats replace from 20 to 50 percent of the water with Alcohol. A general disadvantage with Formalin or Formal-alcohol preservation is that colour will be bleached or removed entirely. A solution made by adding 20 grams of Phenol e.p.; 20 grams Lactic acid, specific gravity 1.25; 0.2 grams Cupric chloride; 0.2 grams Cupric acetate; and 20 Cubic centimetres of Distilled water can preserve green colour of plants like Fern prothallia. For retaining colours, Knudsen (1972) suggests that specimens to be placed in a 5 % solution of Copper sulphate for 24 hours. They should
then be washed several times in water and placed in a solution made up of 16 ml Sulphuric acid; 21 Sodium sulphite; and 1 liter water.

To preserve cut flowers for temporary exhibit, Hangay & Dingley (1985) prepared solution consists of 22 ml Salicylic acid; 20 ml Formaldehyde; 57 ml Ethyl alcohol; and 1137 ml Distilled water.

For the preservation of green plants, Hangay & Dingley described the following methods. All the air removed from the intercellular spaces using a vacuum chamber or by immersing it in 90 - 95 % Alcohol. The plant can then be placed into 5 % Glycerine to which has been added enough Copper sulphate or Copper acetate to impart a bluish tint. The Copper combines with the Chlorophyll to produce Copper phyllocyanate (Hopkins, 1923) which is insoluble except in strong alcohol and is not affected by light. For red and green Apples in 40 ml Distilled water; 2 g Zinc chloride; 2 ml Formaldehyde; and 2 ml Glycerine were used. For yellow and red Apples in 750 ml white Paraffin oil mixed with 10 ml Formaldehyde can be used. Place the Apples in this solution and kept for two weeks in sealed container, and stored in the solution of Sulphur dioxide. Sharon Bale (2004) used Glycerin to preserve foliage by replacing the natural moisture present in the leaf with a substance that maintains the texture of leaf and some times the colour too. Different proportions of Glycerin and water also used. For thick textured foliage 1 part Glycerin to 2 parts water and for fine textured or thin foliage 1 part Glycerin to 3 part water. In this method natural colour of foliage do not preserve. Foliage of different plant alter their colour as Beech leaves generally turn brown, Boxwood generally turns a golden colour, and Croton colour fade slightly.
2.2 Dry Preservation

Holmes, E.M. (1903) adopted the plan of placing carefully dried leaves in bottles, placing at the top of the bottle a lump of Quicklime on a piece of brown paper, and then fastening down the stopper with Vaseline, leaving the specimen for a fortnight, and then removing the lime and refastening the stopper so as to exclude air. In this way the leaves retain their natural form without becoming broken and the colour remains just the same as when first dried. The specimens exhibited have been kept in full daylight for the last two years after being treated as above explained. If the 12 per cent of moisture had not been removed by the aid of lime they would already have become of a yellowish tint and have required renewal. Dunlop, G.A. (March, 1908) adopted a method of drying plants without pressure. He tried two media, with a certain amount of success, namely Silver sand and Boxwood sawdust. In the process, selected specimens were placed in Silver sand to dry. Fine backed Sand were used as coarse Sand injures the delicate organs of the plant and backing was done to destroy the bacteria and other lurking organisms. The plants placed in the box according to the manner of growth. The plant being arranged in its natural attitude and the sand should be put in gradually and in small quantities. After the plant has been fixed so that it will stand without the support of the hand, allow the sand to fall slowly on the point of the trowel, splashing thence on to the plant in a sort of fine spray. In this way the sand finds its way into all the crevices and falls round such delicate organs without injuring them. Then the box now be placed where a current of
air reaches it. He does not advice any artificial heat as it injures the colours
of the flowers and gives the foliage a hard and brittle appearance. He advised
to kill the woody tissues dipping of specimens into boiling water before drying
as they may remain fresh in the Sand for weeks. The specimens will probably
be dry in ten days or so, but they receive no harm by being left longer in
sand. After removing specimens from sand, they should then immediately be
dusted with a small camel-hair brush. He has also used another material
namely Boxwood sawdust which proved better results than Sand. One very
gratifying result is the preservation of the natural texture of the leaves, which
is not attainable by the Sand method. He tried a number of experiments to
counteract the problem of fading natural colour after drying by staining and
painting, but not found good results. The nearest approach to success was
obtained by applying aniline dye, but the leaves dried in unnatural shapes that
were very unsightly. Mosley, S.L. (May, 1908) conducted some experiments
for drying plants in Calais sand. About this time, or soon after, Mr. English
of Epping, published a little booklet on the subject, and later on Mr. Gorge
Purbin, of Wakefield, was very successful in drying autumn foliage of which
he made decorative cases, mounting the plants on black velvet. Mosley found
that a gentle heat in drying was an advantage, as if dried fairly quickly the
plants kept their colour better, and to take away the brittleness. The drying
boxes were put into a cellar for an hour before emptying the Sand, which was
done by withdrawing a cork at the bottom of the box; the sand ran out
gradually. He has faced some difficulties that after drying the plants were
affected by moisture, and would flag and droop by their own weight. This
problem was overcome by giving a thin coating of Shellac which prevented the moisture acting on them. The Lac used for this purpose should be white dissolved in Wood naphtha, and just sufficiently strong to leave no perceptible gloss more than would be seen on a plant when moist. Finely ground colouring matter has been added to this solution to brighten the colours. For this purpose author advised permanent colours. Prof. J.W.H. Trail, F.R.S. (1908) preserved the green colour of plants with the principle is to produce permanent compounds of the colouring matter. Trail proposed the process of treatment in a solution of Copper acetate dissolved in strong Acetic acid with the objective to form permanent green compounds of Chlorophyll and Copper by boiling solution. This process of green colour preservation is not equally important for all green coloured plants. This process includes the dipping of specimen in the boiling solution for a time varying from half-a-minute to about five minutes and prolonged washing after treatment, generally for an hour or more to get better results. Drying after greening process may be by pressure in drying paper, when the pressure should be light, or in hot sand, the choice depending on the texture of the plant and the readiness with which it is greened; plants which require protracted boiling not infrequently become discoloured in sand-drying. Dr. Fothergill, (1915) has been tried with Sand-drying method and the results have sometimes been pleasing, but on the whole it has been found that colours obtained by drying in a cotton-wool press are more brilliant and are expected to be more stable. He given emphasis on quick drying at a fairly high temperature. Contrasting sand drying with drying in the cotton-press, the writer finds that sand produces too much pressure, does not allow
the moisture to dissipate so readily, and leads to a very marked shrinkage in dimensions. Specimens dried in the herbarium press lose much of their form, but do not shrink so appreciably, appear more substantial, and are more brilliant in colour. Dr. Fothergill does not indicate a desirable or safe drying temperature. For sand-drying in a closed space or oven the writer is inclined to think that the temperature should not exceed 50 °C., but a higher temperature seems safe with the cotton-wool press. Mathews (1920), Bishop (1932), and Rowley (1943) have recommended external application of coal-tar and other dyes on dried plant specimens. This is suitable for preparing exhibits in natural history museums where the emphasis is laid more on the Zoological exhibits than on the botanical ones. But, owing to the shrinkage and distortion that the specimens suffer on drying and owing to the unsatisfactory nature of the coal-tar dyes in the tropics, and this method should be unacceptable to institutions where Botanical specimens are given important place. Baker, G.E. (1949) preserved flowers in deep freeze. Collected flowers packaged in lined paper bags of the type sold for food processing and placed in a commercial deep freeze locker. This technique useful in laboratory only for few hours to few months. According to Davies, D.A.L. and V.S.G. Bangh (1956) specimens dried in vacua using a water pump or very rapidly, preferably at low temperature, with a high-vacuum pump. In some instances green specimens retained their colour, but in others where green colour survived the drying process, but this colour faded in a few weeks even in a sealed tube of nitrogen in the dark. Apart from this difficulty, specimens have been stored after freeze-drying without deterioration for more than a year in
a laboratory environment. Womersley, J.S. (1957) dried the plant material by the following methods: specimens were placed individually between sheets of newsprint and placed between a pair of latticed frames of dressed timber and then specimens were placed submerged in the solution of 4% Formaldehyde. Specimens were left in the tank of Formalin for 18 to 24 hours, then removed, and drained of free liquid. Specimens were dried artificially and they were little impaired by comparison with the specimen dried directly. The yellow green colour of the finally dried specimen of Aluminium accumulating plants, e.g. Symplocos were retained. Squires, Mabel (1958) dried the plant materials in dark, cool and dry places by hanging upside down with precautions like cutting flowers before they reach full maturity. Plants should not be covered, shut up in a closet or exposed to direct sunlight while drying. By this technique in 8 or 10 days the majority of plants were dried but weather conditions at the time of drying will govern the number of days required. Hanged plants provided with free circulation of air in drying rack. Harris, R.H. (1964) described the drying technique of Vacuum dehydration and Freeze drying for Animals, Fungi, Algae and some flowering plants. In this method specimens first frozen at -15 to -20 °C for a few hours; then placed in a vacuum chamber at the same temperature together with a quantity of desiccant for absorption of the vapour. In case of vacuum dehydration specimens frozen as before and placed in a glass desiccator over a quantity of desiccant. Vacuum is applied and drying proceeds at room temperature. Freimarck, M. M. (1970) employed the following procedure to preserve evergreens: A freshly cut, short-needled evergreen was dipped upside down
in a drum of Polyurethane Resin # RD 315 and agitated for 10 to 15 minutes. After being hung upside down, preferably outdoors, for 24 hours - it should have stopped dripping - the evergreen was brought indoors and suspended in the same position for three months. At that point, it was sprayed with Acrolite, a transparent green dye that given the needles a lifelike colour. After the tree dries for 24 hours, Krylon was applied to tone down the shiny surface, and the tree was left to dry again. Finally, if more shining is desired, it is sprayed with Krylon Crystal Clear. In this technique of preservation, natural green colour of the specimen is not preserved, at the same time, this technique takes too much time (more than 3 months) to complete the process. A paper by Bhartia et al. (1973) looked at combinational microwave and hot air drying of various substances, including Silica gel. This work shows that microwaves enhance the rate of drying when compared with hot air drying. Curves of the various drying combinations indicate that there may be an optimum arrangement i.e. continuous microwaves and hot air. According to Steedman, H.F. (1975, 1976 a, b) the borax-sand mixture may dry Rose, if kept at a temperature of 40 °C, in about 4 days. He preserved flowers and leaves after drying with the help of Silica gel (30-120 mesh) at 40 °C in the plastic materials. McWilliam, M., Dorothy Shipman (1976) have suggested that herbs and flowers dry quite quickly with an even, low warmth-not less than 21 °C or more than 38 °C. Emphasis is also given on good ventilation as the heat to carry away the humidity of the drying plants. They draw the effect of too much heat or too sunny or light in the results of browning the leaves or at least in the form of dissipate the aromatic properties of specimen. Dark place
with little of no dust, but warmth and plenty of air advocated. Davitt, Laurence M, Thomos Cochis (1978) of Anniston Museum of Natural History, in Anniston, Alabama, prepared Red-oat grass (Themeda trianda) for the use in Savanna diorama. They employed the following method: The mature plants of red-oat grass dug up and washed the roots, and placed the plants in plastic bags as a preservative. Plants were placed in plaster bases. The plaster had been poured around the clumped roots of the grass while the stems were held upright by wires strung in such a way that supporting squares were formed about one foot above a plywood board upon which the plants sat. In 1979 NBRI Lucknow, India published a bulletin on 'Dehydration of Flowers & Foliage' by well known floriculturists and scientists M.A. Kher and J.C. Bhutani. According to Stansfield (1984), for drying botanical specimens, freeze-drying has a limited application. While it is excellent for many categories of Fungi, it is less suitable for flowering plants which lose much of their texture and form and become very fragile. Freeze-drying has been used successfully for Mosses, Lichens and Algae. Hangay & Dingley (1985) described the method of dry preservation of plants in their book Biological Museum Methods Vol. 2 by pressing and drying with the help of plant press. For quick drying plant press placing in drying cabinets for one to three days at 35 °C. Plants such as mistletoe and fig killed by freezing, placing them into boiling water for a few minutes, or by soaking them in 100 ml Glycerine, 100 ml 50% Ethyle alcohol, 5 ml Formaldehyde, 5 ml Glacial acetic acid, and one lump of Copper sulphate for 10 days (or until normal colour prevails). He has suggested some solutions of different preservatives for preserving various
coloured flowers prior to embedding the flowers in polyester resin. Chase and Hills, (1991) has compared Silica gel with Drierite (CaSO₄) as a suitable desiccant for drying leaf samples. The most significant finding of their work was the coarser sizes of silica gel are not as efficient at drying as the smaller sizes are. The study concluded that Silica gel is a better desiccant than CaSO₄ as it has a greater capacity (31% of its weight) and is available in finer mesh sizes. Young, E. et al. (1992) have experimented with Glycerine, Alcohol and Acetone in a 2:1:1 ratio. Fabric dye added to this solution to match colour of the seaweed. All the chemicals and dye mixed thoroughly. After the seaweed was added to the solution, the containers were covered by either a glass plate or aluminium foil to minimize evaporation of the Acetone. They were then placed in a fume hood. After two weeks seaweeds removed from the solution and rinse briefly and set out to dry. S.K. Datta (1997) of National Botanical Research Institute, Lucknow, India has made further improvement in the dehydration technique, since the publication of the first bulletin (1979). S.K. Datta, Head of the Floriculture Section of NBRI described different drying methods for flowers and foliage. It include Room Drying, Sun Drying, Oven Drying, Vacuum Drying, Microwave Oven Drying using Silica gel, Sand to embed the specimens and so on. Vacuum Drying and Microwave oven drying methods are quite satisfactory than Air Drying, Room drying, Sun drying and Oven drying. In Microwave oven drying, specimens are covered by fine Silica gel in non-metallic earthen or glass containers and kept in the microwave oven for 1 - 4 minutes depending upon the type of specimen. The material after taking out from microwave oven is kept out side in dry atmosphere for
setting for 2 - 5 hours. *Antirrhinum majus, Chrysanthemum, Dahlia, Helichrysum bracteatum, Helipterum roseum, Nymphaea spp.* etc. dried with colour darker than original by this method. Fuller and Barbe (1981), Hall (1981), Sauleda and Adams (1981) refer to drying specimens in a microwave oven. However, as most microwave ovens are limited in size, and because of the limited penetration of microwaves, this technique is best used on small collections. Hills (1993) reported that the use of microwaves on specimens may cause damage to seeds. Philbrick (1984) suggested other possible damage at the morphological and macromolecular level, thus reducing the long-term value of the specimens for some uses. Bacci et al. (1985) reported that microwave drying is a very effective method, but they noted that it adversely affects the organells, which are preserved only if the specimen is dried at air temperature. Ronald C. Smith (April, 1992) Horticulturist and Turfgrass specialist of North Dakota State University of Agriculture and Applied Science, described various methods of flower preservation by Air drying through hanging in warm, dry, dark place. Flowers take one to two weeks or more time for drying depending on the moisture content of the cut stem and relative humidity. Suggested flowers to dry include: Straw flowers, Goldenrod, Hydrangeas, Celosia (Crested and Plumed types), Queen Anne's lace, Statice, Baby's breath, Millet, Xeranthemum etc. Two parts of water to one part of Glycerine mixture also used to replace water content of some plants. By pressing and drying method in which relief is lost, flowers like Aster, Chrysanthemum, Cosmos, Dahlia, English daisy, Geranium, Marigold, Pansy, Poppy, Rose, Zennia etc. required time from two to four weeks.
depending on the flower size or tissue content. In the sand drying method very fine, clean, dry, and preferably salt free sand may be used for embedding flowers in their prime and process them quickly to prevent wilting recommended for better result. Homemade mixture of equal proportions of powdered Pumice and Yellow Corn meal or equal proportions of borax and Yellow Corn meal and Silica gel, for give better results from other drying agents also used to dry the specimens. Drying temperature and notes on colour condition does not mentioned by him. Flowers that dry well in either borax or Silica gel include: Rose, Aster, Carnation, Marigold, Dahlia, Larkspur, Geranium, Zinnia, Chrysanthemum and Delphinium. For Microwave drying since flowers vary in moisture content, texture and density, care should be taken to use the same sized flowers from one species at a time. In this method bright coloured flowers dry best. Flowers such as Lilies, Roses, Violets, Zinnias, and Dahlias work well with this process. Catherine white (2002) dehydrated flower by hanging upside down in a cool, dark place. Kathy Reid (2002) preserves flowers by freeze drying technique. Pretreatment and rehydration before freeze drying and post treated to retain their shape, colour and texture after freeze drying, Coating of transparent layer to protect from humidity also employed. Mature cuttings taken and crush the stem 2 inch above the cut end. Specimens inserted in hot Glycerin (130 - 140 °F) and allowed them to remain in the Glycerin for 3 weeks and then air drying employed. Dried specimens coated with Verathane in the following manner: Simple dip the specimen into Verathane, and let the excess drip off and dry. Dried specimen by this technique do not retain their natural colours. Sharon Bale (2004) preserved the flowers by drying with the help of Silica gel.
Flowers are covered completely, making 1/2 inch layer of desiccant at the base. Flower placed faced down and face up according to petals. After drying, flower removed from the desiccant and finished by air drying. They also sprayed by ordinary hair spray, aerosol lacquer or sprays, protecting from direct sunlight and high humidity. They also described the method of air-drying of plant material at dry area, low light, and good air circulation show good result. Silica gel, Borax, Sand, Sawdust, Perlite, Cornstarch or a combination of these also used for drying flowers. Non-iodized salt with a mixture of 2 parts Borax, 1 part fine sand also used.