EFFECT OF SELECTED PRESERVATION TREATMENTS ON THE QUALITY OF EXOTIC FLOWERS IN FLORAL FREEZE DRYER

E. SHIRIN HIMA BINDU

B.Sc. (Home Science)

MASTER OF SCIENCE
(HOME SCIENCE)

2011

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By
E. SHIRIN HIMA BINDU

B.Sc. (Home Science)

THESIS SUBMITTED TO THE ACHARYA N.G.RANGA AGRICULTURAL UNIVERSITY IN PARTIAL FULFILMENT

OF THE REQUIREMENTS FOR THE AWARD OF THE

DEGREE OF

MASTER OF SCIENCE
IN THE FACULTY OF HOME SCIENCE

CHAIRPERSON: Dr. MAHALAKSHMI V.REDDY

DEPARTMENT OF RESOURCE MANAGEMENT &

CONSUMER SCIENCES

COLLEGE OF HOME SCIENCE
SAIFABAD, HYDERABAD – 500 004

ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY

2011

CERTIFICATE

Ms. E. SHIRIN HIMA BINDU has satisfactorily prosecuted the course of research and that thesis entitled **"EFFECT OF SELECTED PRESERVATION TREATMENTS ON THE QUALITY OF EXOTIC FLOWERS IN FLORAL FREEZE DRYER"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that neither the thesis nor its part thereof has been previously submitted by her for a degree of any University.

Place: Hyderabad **Dr. (Mrs.) Mahalakshmi V.Reddy**

Chairperson

Date:

CERTIFICATE

This is to certify that the thesis entitled **"EFFECT OF SELECTED PRESERVATION TREATMENTS ON THE QUALITY OF EXOTIC FLOWERS IN FLORAL FREEZE DRYER"** submitted in partial fulfillment of the requirements for the degree of 'Master of Science in Home Science' of the Acharya N. G. Ranga Agricultural University, Hyderabad is a record of the bonafide original research work carried out by Ms**. E. SHIRIN HIMA BINDU** under our guidance and supervision.

No part of the thesis has been submitted for any other degree or diploma. The published part and all assistance received during the course of the investigations have been duly acknowledged by the author of the thesis.

Thesis approved by the Student Advisory Committee

Chairperson : **Dr. (Mrs.) Mahalakshmi V.Reddy**
Professor & Head
RMCS Department
College of HomeScience (Signature)
Hyderabad - 500 004

Member : **Dr. (Mrs.) D.RATNA KUMARI**
Associate Professor
RMCS Department
College of HomeScience (Signature)
Hyderabad - 500 004

Member : **Dr. (Mrs.) S.RATNA KUMARI**
Associate Professor
HDFS Department
College of HomeScience (Signature)
Hyderabad - 500 004

DECLARATION

I, **Ms. E. SHIRIN HIMA BINDU,** hereby declare that the thesis entitled **"EFFECT OF SELECTED PRESERVATION TREATMENTS ON THE QUALITY OF EXOTIC FLOWERS IN FLORAL FREEZE DRYER"** submitted to **Acharya N. G. Ranga Agricultural University** for the degree of **Master of Science in Home Science** is the result of original research work done by me. I also declare that no material contained in the thesis has been published earlier in any manner.

Place : Hyderabad **(E. SHIRIN HIMA BINDU)**

Date : I. D. No.

Acknowledgements

I humbly extol the "Jehovah Nissi" for having bestowed upon me His grace and blessings in every humble step I have taken so far.

I express my deep gratitude to my major advisor, Dr. (Mrs.) Mahalakshmi V. Reddy, Professor & Head, Department of Resource Management and Consumer Sciences, College of Home Science, Hyderabad, for her guidance and inspiration offered right from the initiation of the work to the ship shaping of the manuscript. The present work bears at every stage the impression of her wise counsel and concrete suggestions, careful and constructive criticism, constant encouragement and meticulous attention at all stages of the research work. . It was a great pleasure for me to conduct this thesis under her supervision. Her overly enthusiasm and integral view on research and a task for providing 'Only high-quality work and not less' has made a deep impression on me.

My profound thanks are extended to Dr. (Mrs.) D. Ratna Kumari, Associate professor, Department of Resource Management and Consumer Sciences, College of Home Science, Hyderabad, for her untiring interest and encouragement, useful suggestions and timely help extended in the preparation of this thesis.

My heartfelt thanks are due to Dr.(Mrs.) S.Ratna Kumari, Associate Professor, Department of Human Development and Family Studies, College of Home Science, Hyderabad for the advice and help given during my research work.

I am extremely grateful to Dr.(Mrs.)P.Radha Rani, Dr.(Mrs.)Y.Vijaya Lakshmi and Dr. (Mrs.) D. Ratna Kumari for their co-operation in helping me in carrying out the research work.

I deeply acknowledge the help of Mr. S.R.K. Prasad, Anachrom Systems, Hyderabad and Mr. Balaraman and Mr. Venkataraman, Delvac Pumps, Chennai for extending technical support in handling freeze dryer.

I am proud to have family, well supported in all aspects and it is a pleasure to express my reverence to my parents for all their love and guidance, Dr. E. D. Bharath Kumar and Dr. E. Agatha, my sisters Rachel and Shirley, and my brothers Benhur, Neville and Moses for their blessings, moral support, constant encouragement and dedicated efforts to educate me to this level.

I feel immense pleasure in expressing my gratitude and regards to my grandmother Mrs. P. Kanaka Dharmaraj and my uncle E.D. Jaya Kumar for their blessings, love and affection and with those encouragements, I could complete my study.

I extend my heartful thanks to my friends Swarupa, Abhiram, Harshita, Maria, S. Dhanalakshmi, Ps.Prabhu, Ps.Rekha, Ps.Comfort, K. Dhanalakshmi, Suresh, Paul, Imran, Saleem and Ravipaty Venkat for their constant encouragement, good co-operation and help rendered during the study and making it memorable one.

Lastly I want to thank one and all who helped me in completion of this work.

(E. SHIRIN HIMA BINDU)

LIST OF CONTENTS

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

4.8	Effect of treatments on Bird Of Paradise	
4.9	Score values for colour, texture, form and appearance of Bird of Paradise	
4.10	Effect of treatments on Asiatic Lily	
4.11	Score values for colour, texture, form and appearance of Asiatic Lily	
4.12	Effect of treatments on Orchid	
4.13	Score values for colour, texture, form and appearance of Orchid	
4.14	Effect of treatments on Statice	
4.15	Score values for colour, texture, form and appearance of Statice	
4.16	Effect of selected treatments on Freeze Dried Exotic flowers	
4.17	Freeze dried Exotic flowers in different packaging material	
4.18.	Presentation of freeze dried Exotic flowers in display cases	

NAME	:	**E.SHIRIN HIMA BINDU**
I.D.NO.	:	**HHM/2009-20**
TITLE OF THE THESIS	:	**EFFECT OF SELECTED PRESERVATION TREATMENTS ON THE QUALITY OF EXOTIC FLOWERS IN FLORAL FREEZE DRYER**
DEGREE TO WHICH IT IS SUBMITTED	:	**MASTER OF SCIENCE**
MAJOR FIELD	:	**FAMILY RESOURCE MANAGEMENT**
FACULTY	:	**HOME SCIENCE**
MAJOR GUIDE	:	**Dr. (Mrs.) MAHALAKSHMI. V. REDDY**
UNIVERSITY	:	**ACHARYA. N. G. RANGA AGRICULTURAL UNIVERSITY, RAJENDRANAGAR, HYDERABAD – 30**
YEAR OF SUBMISSION	:	**2011**

ABSTRACT

Flowers have a universal appeal and they are never out of fashion. Exotic flowers that thrive naturally in tropical climatic conditions hold a special place due to their unique colours, form and exquisite beauty. Exotic flowers and plants add that extra special touch to gardens, homes, and all occasions - weddings, celebrations There is an increasing demand all over the world for the decoration of living and working places with eco-friendly things like fresh foliages and flowers. Flowers play an important role in enriching the interiors of a home or an office.

Fresh flowers need special and continuous effort to avoid their premature wilting, while they eventually fade out over a short period of time**.** Freeze-drying is a process that retains the colour, form, texture and appearance of any perishables. While frozen, the moisture is removed by way of vacuum. Preservation of flowers in freeze

drying process retains its pigment (colour) and structural parts (cells) and thus remains as fresh bloom for years. This study was taken up to explore the effect of selected preservation treatments on the quality of exotic flowers in floral freeze dryer.

Experimental research design was adopted for conducting the study. Floral freeze dryer available in the department was used for this research. Five varieties of exotic flowers *viz.*, Anthurium, Bird of Paradise, Asiatic Lily, Orchid and Statice were selected through purposeful sampling method. Fresh and fully bloomed flowers suitable for freeze drying process were chemically treated with five basic and five improved compositions Flowers were transferred to freezer chamber and were allowed to freeze dry under vacuum. Processed flower were analyzed before and after experiments to know the effect of these treatments on colour, form, texture and appearance of freeze dried flowers.

It was found that the each of the chemical tested on fresh flowers reacted differently on colour, texture and appearance of flower petals. Citric acid, Sodium citrate, Cupric Sulphate and Sodium formaldehyde Sulphoxylate retained colour pigments while harsh and mild alcohols dissolved colour pigments and dehydrated the flowers. Silicone resin and fluid formed glossy shield on the surface. These outcomes proved the influence of chemicals on preservation qualities of flowers.

Experiments conducted with basic composition and improved composition on exotic flowers revealed that, each composition had different influence on flowers. Irrespective of flowers, each of the basic compositions influenced colour pigments but appeared dry and brittle while the improved compositions had an influence on their texture, form and appearance of the flowers. Composition I and II which had only three chemicals with pH value of 5.0-5.5, consisting of harsh dehydrant, urea-compound and biological fixative, retained colour of flower petals, but flower texture, form and appearance needed improvement. Composition III and IV that had 6-7 chemicals with pH value of 6.0–6.5, consisting of mild dehydrant, urea-compound, biological or tissue preservatives and biological fixatives retained colour pigments and produced acceptable results in all flowers. But Composition V with pH value of 6.5-7.0, which had group of dehydrating alcohols, biological or tissue preservatives, environmental fixers, biological fixatives, buffers, mordant's and modifiers were found to yield better results for retaining colour, form and appearance of all flowers. Texture which is one of the important qualities needed further improvement

Physical examination of freeze dried flowers by the experts complemented the above observations. ANOVA one way classification analysis proved the hypothesis of influence of treatments on the quality of flowers at 5% level of significance.

Flowers stored in air-tight plastic containers proved to be better than those stored by inserting in polythene covers and zip lock vacuum bags with respect to colour, form, texture and appearance of flowers. However, flowers immediately transferred to sealed display cases remained fresh and attractive. This proves the importance of proper after care for preserved flowers.

From the present study it can be concluded that there is an effect of preservation treatments on the quality of exotic flowers when freeze dried. Further research to improve the textural quality can result in near-real quality to natural flowers.

Chapter I

INTRODUCTION

Love for flowers is a natural instinct for all. Flowers are associated with mankind from the dawn of civilization. In the modern era these have become an integral part of human life. Giving flowers to another person during various occasions signifies ones emotions towards the other, for celebrations, as gifts, to convey thanks, for pleasure, as a decoration, and in times of sorrow. Flowers bring outdoor into homes and offices and flower arrangements change the colour and feel of an interior for a relatively small investment. In interior decoration, the flowers play an important role in enriching it.

Flowers appear in thousands of different varieties, shapes, sizes, colors and forms. Botanists tell us there are some 10,000 different kinds of flowers, a claim that's easy to believe with all the diversity found in many backyards and fields. Some flowers bloom in the summer, while others decorate the winter, spring or autumn landscape. Growing conditions of flowers differ with some thriving in full sunlight or shade, while others prefer partial shade or sunlight conditions. But some flowers are less common than others, found in many different locations and easily recognized; there are also a great number of rare and exotic species, some of which have radically different shapes and textured or aromas.

Worldwide, floriculture is pondered as a huge industry. Florists sell several of native and exotic flowers, particularly the herbaceous annuals, biennials and perennials and bulbous flowers grown in own country, have been introduced from abroad. Among the several kinds of flowers grown in the garden, only a few are natives of our country. Tropical Flowers are those that thrive naturally in tropical climatic conditions. Tropical flowers hold a special place in the hearts of flower lovers due to their breathtaking fragrance and exquisite beauty. Many varieties of exotic flowers have come from Europe, America, Africa, China, Japan and other countries. Colours, shape and texture of flowers like Orchids, Anthuriums, Rhizomes, Gingers, Heliconias, Birds of Paradise, Lilies etc., are more popular with the flower lovers as these create visual interest. There

is also huge demand for these flowers, as people use such flowers for interior decoration of their homes, offices or any other work place.

Fresh flowers are admired by all, and these play a key role in interior decoration. Interiors with flowers convey a feeling of positivity and happiness for all those who view it. One of the most used phrases in interior design is “bring the outside in”. The easiest ways to accomplish this task is with fresh flowers. It is easy and economical to bring in the environmental benefits of the colour and aroma of flowers through floral arrangements inside the home or workplace.

A critical factor in floral arrangements and cut flowers is their high degree of perishability. Spoilage of flowers is much greater and faster if they are stored and handled in sub-optimal conditions of temperature, humidity and air pressure, which differ for each flower. Once harvested, flowers continue to ripen and decay. This process can be delayed only slightly with intermittent care, and invariably it decays and calls for replenish. Increasing the life span through preservation methods is an ideal way to enjoy the beauty of valuable flowers. It's probably an ancient desire to preserve what is precious and beautiful. Though, nothing can replace the beauty of original flowers, consumers prefer flowers that do not dry up and remain beautiful forever; do not have to change the water in vase every day and can keep for long time; low maintenance.

Need for flower Preservation

Flowers preserved from special occasions, evoke the past, and leave us with sentimental thoughts. They help us commemorate good times punctuating every celebration in our lives. From weddings, anniversaries, births, the passing of a loved one, retirement, to Mother’s Day and Valentine’s Day, freeze dried flowers give us life long memories of the event, and continue to enrich our lives. When we savour these moments for ourselves, friends, and family, it only adds a higher quality of living for everyone. Catching sight of flowers growing in all their grandeur and simplicity makes it tempting to wish the season would go on and that the flowers never fade. Moreover, there is a non-availability of fresh flowers and foliages all round the year in all places (Datta, 2004).In such an attempt, different methods for drying and dehydrating plant materials have been tried to retain their colour and form for a very long period (Bhutani, 1990).

Flowers and foliage consists of more water, dehydration is necessary for getting dry flowers. Artisans discovered that using desiccants (drying agents like borax, silica gel or even sand) could stop the flowers petals from shrinking while they dried, resulting in a much more natural look. These techniques are still widely used today. Unfortunately, these techniques have a serious shortcoming as they create a fragile end result. The flowers become quite delicate and papery (Bull, 1997).

The latest technology has come to the rescue with a marvellous technique known as freeze drying. It is the newest and most effective method for floral preservation today. The ancient Incas were the first to learn the benefits of freeze drying. They discovered sublimation as well suited for preserving sensitive biological materials. The three reasons for this is that, first, freezing slows or stops most chemical reactions. Second, the process occurs under a vacuum, and the absence of oxygen prevents oxidative reactions. And third, the process can be performed at very low temperatures - lower than any other drying method. They discovered that when they dried food at high elevations, the results were better. Even though the food would freeze, it would dry well if left exposed to the sun. The reduced pressure at high elevation, combined with the dry air and energy from the sun, had caused sublimation to occur.

The general process of freeze drying objects has been around for over 70 years. Freeze drying (technically known as “lyophilization”) is the process of lowering the temperature of an object and then using a vacuum to extract all the moisture from the item. The process for freeze dried flowers began in 1989 in abroad. Since that time, freeze-drying has been used as a preservation or processing technique for a wide variety of products. Some of the applications include the processing of food, pharmaceuticals, and diagnostic kits. But the use of this technology for flower preservation is recognized only since last two decades.

Freeze drying flowers is the blend of science and art. It retains the shape and colour of the flowers almost as if they are still fresh. Flowers are chemically treated to enhance colour and to increase pliability. As a result, the flowers will maintain their original colour and shape for many years to come. Each flower is dipped individually in a solution that seals the flower and allows them to be soft and pliable. By removing all the moisture from the flowers, the colours are preserved (though they may take on a

slightly antiqued look). Water-based, non-hazardous, and biodegradable chemical treatments applied to the flowers prior to freezing that produces an end product that is amazingly like the fresh flower. A Study undertaken to preserve flowers in freeze drying process by Reddy and Kumari (2010), revealed that flower retain their colour and appearance close to nature after pre-treatment. Because they immediately begin to freeze, the flowers are not given the chance to wilt or change shape. If the Freeze Dry Flower Industry continues to grow, many more people will enjoy the everlasting realistic flowers in their homes and offices.

Rationale of the study

With changing life styles and increased urban affluence, Consumer's interest to flower has assumed definite commercial status in recent times and during the past 2-3 decades particularly. There is an increasing demand for modern & exotic flowers from individuals or households, institutions and hotels also continue to be the dominant buyers in the market. The floral industry today has grown in large proportions and offers a wide scope for growth and profits. Today there is a dire need to maintain and grow the technology related to flowers as it is one of the most profitable business with low investment options, which is growing at a very fast pace. As far as floriculture is concerned, the steady increase in flowers floriculture has become one of the important commercial trades in agriculture which is attracting profits and new ideas to breed new variety of flowers with the concept of cross hybridization. At present dry flower industry is growing very fast with more than 60 per cent share to the floriculture industry in India (Ranjan and Misra, 2002). Hence commercial floriculture industry is attracting hi-tech activity to have a better growth and quality of the flowers.

Drying and preserving flowers and plant materials is a form of artistic expression that was very popular during the Victorian age and has once again gained popularity. Although, dry flower production is a smaller component of Indian floriculture industry, but the demand of Indian dried flowers and plants has sharply increased world-over in a short span somewhat on the expense of fresh flowers. Dried flowers are long lasting, can be used several times and also meet the decorative demand throughout the year (Susan, 1990).Freeze dried flowers offer an outstanding floral preservation improvement over air-dried flowers or other methods of preservation that result in wrinkled and shrivelled flowers. They often fall apart in 6 to 12 months or begin to mould. Preservation of flowers in freeze drying process assumes to retain

pigment (colour) and structural parts (cells) and thus remains as fresh bloom for years. The main advantage of freeze-drying is that it results in products that appear almost like the fresh originals. Physically, the original texture, structure, and highly volatile components including aroma, are important criteria for assessing the quality of flowers. can be retained in many freeze-dried food products. Freeze-dried flowers are of sufficient value such that they justify the substantial cost of freeze-drying. Freeze dried flowers can find a market potential as it can be used as attractive accents, while decorating the interiors for any home, commercial centres and as gift articles for any occasions.

Since freeze-drying of flowers is a relatively new preservation process for the preserved plant material industry, and exotic flowers have high decorative and aesthetic value, research in dimension will generate new opportunities for farmers to produce good quality flowers and provide opening for women entrepreneurs for production of everlasting flowers carved though this technique to capture memories and create wonderful works of art. Dried flowers can be effectively used for making decorative floral craft items for interior decoration and commercial exploitation (Ranjan and Misra, 2002).Hence this study on "Effect of Selected Preservation Treatments on the Quality of Exotic Flowers in Floral Freeze Dryer" was undertaken to with the following objectives:

Objectives of investigation:

1) To standardize the preservation treatments suitable for selected exotic flowers in freeze drying process.

2) To study the effect of treatments on the qualitative characteristics of selected flowers.

3) To evaluate the effect of different packaging methods in retaining the qualitative characteristics of freeze dried flowers.

Delimitations of the study:

1. Selection of exotic flowers was limited to locally available in the market.
2. Study was restricted to pre-treatment only.
3. For evaluating different packaging methods post-preservation was done only for one month duration due to shortage of time.

Chapter II

REVIEW OF LITERATURE

Fresh flowers are beautiful and delicate but it becomes a stupendous job to maintain their charm for a long time. The delicate natural colours of the flowers tend to fade relatively quickly and the flowers are also extremely brittle, fragile and highly susceptible to damage in extremes of temperature or humidity. Many dehydration techniques have been in vogue, of which freeze drying flowers to retain the shape, colour, appearance and artistic value is a new technique, which has not gained any attention. As there has been no research work taken up in this new field, topics related to research were reviewed under the following heads.

2.1 Significance of exotic flowers

Flowers come in different colours, some of those colours are common but some are rare and this rarity adds to their beauty and makes them even more exotic. An uncommon, striking spirit that symbolizes a sense of adventure and singular brilliance is Exotic. The popularity of exotic flowers depends on their exclusive aroma,

exquisiteness or both. Sometimes, popularity depends on some cultural traits peculiar to that geographical region. The exotic and natural beauty of the Indian flora is one of the most pristine in the whole world.

According to Eco India (2008), there is virtually no area of India without its particular treasure or species of special beauty or interest. Due to the wide range of climatic conditions, India holds rich variety of flora that no other country can boost of. India covers more than 45,000 species of flora, out of which there are several species that are not found anywhere else. India has some of the unique flower plants and is a magnet for many visitors both locally and from overseas. Lotus is the National Flower of India. The North -East -India has the profuse growth of orchids and marigold plants. No fewer than eighty percent of the Indian flower plants are endemic i.e. occurring here and nowhere else. Flowers in India are used on large scale in weddings, making garlands and the purpose of decorations. Flowers are intricately entwined in the social and religious fabric of our country and no function is complete without flowers.

There are several kinds of flowers grown in the garden, only a few are natives of our country. The important flowers which are natives of particular geographic region and which are under cultivation in different parts of the world are orchids, rhododendrons, musk rose (Rosa moschata), begonia, balsam (Immpatiens balsamina), globe amaranth(Gomphrena Globosa), gloriosa lily (Gloriosa superba), foxtail lily (Eremerus himalicus), primula (Primuladenticulata P.rosea), blue poppy (Meconopsis), lotus (Nelumbo nucifera), water lily Nymphae spp.), clematis (Clematis Montana- a climber) and the wild tulip of the Himalayas (Tulipa stellata and T.aitchisonii). Of these, only the lotus has been mentioned in the ancient Sanskrit scripture of the Vedic times. Mention of the lotus was also made by Kalidasa in his play Shakuntala. The poet Asvaghosa (A.D.100) also mentions the lotus in his Buddha Charita.

Barua (2005), a flower dealer and the vice president of the flower mandi in India stated that till a few years back, roses of different varieties were the main export items for us. But now even tulips and lilies cultivated in India are being exported to countries like Japan, Saudi Arabia and Pakistan.

Joshi (2005) Chairman, Parliamentary Standing Committee on Commerce, in his Seventy Sixth Report on Floriculture presented to The Rajya Sabha, stated that Flowers have been an integral part of the Indian culture since times immemorial. Various types of flowers, particularly the herbaceous annuals, biennials and perennials and bulbous

flowers, grown in our country, have been introduced from Europe, America, Africa, China, Japan and other countries during the Mughal and British periods.

World Is Natural (2009) web page viewed, the invigorating beauty of flowers have always fascinated and enthralled people around the globe over the ages. Their beauty lies in their suppleness, their pleasant aroma and their diverse colours. Over the centuries, flowers have always enjoyed special interest and affection from lovers and poets through gifts and poems. These tranquil beauties have also placed them distinctively in mythology, folklore, and religious symbols of different races. Nothing conveys single meaning of love, beauty and pure innocence in full quintessence than flower.

Sparks (2006) said that tropical blooms are all extraordinarily long-lasting as cut flowers. Tropical blooms, such as Orchids, Heliconias, Anthurium, Protea, Bird of paradise and Ginger will last from as much as a month when cared for properly. Because the blossoms of tropical flowers are typically large, uniquely shaped, and vibrant in colour, one can get away with using only a few blooms. Hoffman (2010) informed that there are different species of exotic flowers and the most common ones where Anthuriums, a heart shaped flower which are almost always present on bouquets. Orchids are also considered as a rare plant that has over 20,000 genuses. These flowers are known for their beauty and colour that provides peace. Birds of Paradise are set apart for their exotic shape that resembles a bird. Heliconias are known for their multi-faceted structure and grow large and colourful bracts that mostly hide the flowers underneath. Calatheas are beautiful blooms that are grown mostly in forests and are pollinated by bees and other insects. Another characteristic of exotic flowers is the unique fragrance that emanates from many of these blooms.

As cited by Sumangala and Sidhu (2011) conservation and utilization of Indian ornamental flora is the need of the hour. It is very much essential to create awareness about the potential of our native species and utilizing them in the floriculture as well as landscaping Industry. There is a need to educate and to sensitize research, academic and developmental institutions on the value of native species for social, economical and environmental benefits to the community and to the country

Exotic flowers hold a special place in the hearts of flower lovers due to their breathtaking fragrance and exquisite beauty. Exotic flowers are beautiful and these are used to make attractive floral arrangements all over the world.

2.2 Economic importance of exotic flowers

India has a rich flora and serves as a raw material supplier for dried flower industry and has a potential for worth of Rs.40 million market value in this sector. To encourage the eco-friendly trade, government has given a rebate of 25 per cent on the freight of this product. Quite bulk quantities of the raw material are exported from India to the developed countries like UK, Japan and America, where dried floral arrangements are of great demand (Puri, 1995).

Like more employment generation, the flower crops have the inherent advantage of providing higher productivity per unit of land resulting in higher income. The study of (Alagumani *et. al*,1997) in Madurai district of Tamil Nadu shows that the income obtained from flower was Rs. 9.47 lakhs in the case of Kanakambara (Crossandra) followed by Rose Rs. 8.40 lakhs. These incomes were higher compared to other crops such as sugarcane Rs. 24,298 / ha. The income generation of fruit crops was Rs.20, 000, for vegetable crops Rs.15, 000, Paddy Rs. 10,000 and Ragi hardly Rs. 4,000 per hectare. A study in Farukahabad in Uttar Pradesh shows that the Rose yielded a net income of Rs.1.3 lakhs per hectare, on an average investment of Rs. 11,000 per hectare, and the input – output ratio worked out to 1: 1.76. In the case of Jasmine, the average net returns came to Rs. 1.04 lakhs, on an average investment of Rs. 97,430 per hectare, and input-output ratio worked out to 1:1.73.

Till a few years back, India was known for its roses abroad. Floriculture has come up in a big way in several states in the country including Kerala, Andhra Pradesh, Maharashtra, Himachal Pradesh and West Bengal. With the boom in floriculture, flower exports have also gone up significantly in the last few years. But with floriculture booming in many parts of the country, flowers of some exotic varieties are also making it into the export list. While the flowers of exotic varieties have helped farmers increase their earning, they have also added to the export pie of the dealers. Not to forget the

Indian customers, for whom fresh exotic flowers are now at a sniffing distance, Barua (2005).

Experts estimate that exports from Delhi alone generate nearly 100 crore each year. Flowers worth nearly 100 crore are exported from Delhi. Of this 80 per cent comes through indirect export, while the rest comes through direct export. Indirect export is when dealers from other countries personally visit our market and purchase flowers and direct export is when we export flowers to our regular clients in other countries", says Barua (2005).

Over the last 20 or 30 years, the demand for cut flowers has increased significantly and important changes occurred in consumption patterns. Rather than occasional purchases of traditional species for special occasions, flowers are becoming a regular decorative part of middle-and upper-income homes, and exotic and interesting varieties are increasingly popular. Linked to this change of when, how and which flowers are bought, are how and where these flowers are produced. At present dry flower industry is growing very fast with more than 60 per cent share to the floriculture industry in India (Ranjan and Misra, 2002). In dried flower industry, a turnover of more than Rs. 150 crores is projected every year (Singh, 2003).

Floriculture has emerged as a lucrative profession with a much higher potential for returns than most field and many horticultural crops (Raghava, 2001). In India, we have never looked into the tremendous export potential of dry flower industry and till date it is the most neglected industry. There is an unlimited prospect in this field and only with sustained efforts; we can make a significant presence in the world market. Therefore, there is a need to tune the techniques of drying of flowers with special reference to the available flora and fauna under the conditions prevailing in India. Raj (2003) Dried flowers being cheap and everlasting are fast becoming a favourite among the adventurous flower lovers across the globe somewhat on the expense of fresh flowers. Liberalization of EXIM (Export and Import) policy in India has paved the way for increased export of floricultural products and the contribution of dried flowers is enormous. The organized research and production of dry flowers in the country by making use of rich bio-diversity and cheap labour would further trigger the growth of floriculture industry. According to SADC (State Agricultural Development Committee) Trade Information Brief (2011), although much of the domestic demand in major

consuming countries is satisfied by domestic production, commercial production has become a highly globalised trade.

According to Verma, (2008), seeing flowers are always a pleasant for everyone and with different colours and fragrances, we want them all around us. Flowers do affect our brain and thus our attitude towards our surroundings with respect to our behaviour and working. Berd House Gallery (2011) claims that the flowers are put into various uses by the users starting from home decoration to enrichment of commercial and office spaces. Decorating the interiors with flowers conveys a feeling of positivity and happiness for all those who view it. It is easy and economical to bring in the environmental benefits of the colour and aroma of flowers through floral arrangements inside the home or workplace

2.3 Need for extending shelf life of flowers

Flowers are an emblem of divine beauty, but unfortunately, the joy is short-lived. The greatest desire of a florist is to prolong the vase life of flowers. Flowers are delicate and they need to be preserved as soon as possible. It is very important to maintain freshness until the process of preservation begins, so they are kept cool. The appearance of bent neck (slight bending of the floral axis), wilting of outer petals and yellowing leaves indicate the end of useful vase life of cut flowers (Ketsa and Narkbua, 2001; Reid, 2002). To preserve the best quality of cut- flowers after harvest and to make resistant to fluctuations in environmental conditions, treatment with floral preservatives is recommended (Zencirkiran, 2010)

Ethylene is one of the factors involved in causing senescence and short vase life of many cut flowers (Ichimura *et al.,* 2002). The inhibition of ethylene action by Pulse pre-treatment i.e. drinking process with STS has become an important commercial technique for improving the vase life of flowers, especially when they are to be handled in ethylene-contaminated environments such as supermarkets (Zencirkiran, 2010). It has been reported that the vase life of various cut – flowers such as Carnation, *Matthiola*, *Consolida*, *Chrysanthemum*, *Zingiber*, *Anthirrinum* and *Delphinium*, can be extended by exposure to 1–MCP (Sisler *et al.,* 1996 a, b; Ichimura *et al.,* 2002; Hassan and Gerzson, 2002; Almeida *et al.,* 2002).

The excessive heat and dryness decrease their life further, so one should take extra precautions to avoid their premature wilting. Maintaining a beautiful interior with fresh flowers is a tedious job, especially in summer because fresh flowers have a short shelf life. Flowers for preserving can be collected at different stages of development can be picked for drying purpose throughout the year when they are in peak condition. Anthurium, birds of paradise, oriental lilies, orchids and carnations because they have a shelf life of around seven days compared to roses, which don't last for more than one or two days. Flowers at different stages of development show variation in colour, form, and texture. It is best to cut the flowers in the morning hours after the dew has evaporated from the plants. Flowers, for example, can be cut at the bud stage and at any later stages until just before full flower (Musgrove (1998) Avoid harvesting too much matured flowers as they will generally shed upon drying and will not hold up well in arrangements (Yan, 1999). Use only plants and flowers free of insect and disease damage as the damage becomes more obvious after drying (Trinklein, 2000).

The petals are often very soft and flexible and can bend, curl, twist etc., which makes the shape of a flower appear very different. The shape of a flower also changes with the age of the flower and petals might even fall off. The shape of individual petals, their configuration, and the overall shape of the flower can all be used to distinguish the freshness of flowers. Some flowers have characteristic patterns on their petals. These patterns can be more distinctive, such as the pansy's stripes, the fritillary's checks or the tiger lily's dots or more subtle in the form of characteristic veins in the petals (Nilsback and Zisserman, 2006).

The delicate natural colours of the flowers tend to fade relatively quickly and the flowers are also extremely brittle, fragile and highly susceptible to damage in extremes of temperature or humidity so that special handling and storage techniques are necessary. Without such special techniques, the natural beauty of the flowers is quickly lost and the flowers lose their usefulness for display or educational purposes. (Jennings, 2001).

The preservation of flowers for museum specimens, for educational purposes in the natural sciences and elsewhere, for decorative and ornamental use, for displays and the like has been practised for many years and many processes for such preservation have been described in the literature. Sierra and John (1982) and Jennings (2001) while expressing his views on other Applications of Freeze-Drying stated that "the application

of freeze-dried flowers has a much broader application. He also stated that there are many rare and exotic plants in places like the Amazon forest will soon be extinct because of climatic changes or man's intervention with its natural habitat. It is better to learn how to preserve these plants in their natural beauty to teach for generations yet to come.

Views cited above highlights the significance of extending the shelf life of flowers. By utilizing the flower drying and preservation techniques, one will be able to get more life and more enjoyment from every set of flowers grown or bought in the future.

2.4 Techniques of Drying and preserving of flowers

In reality, the beauty and fresh look of cut flowers can be retained only for few days even by using the best techniques of post-harvest technology, but the charm of dried flowers and foliage can be maintained from a few months to years with lesser cost if protected from the damage of high humidity. In such an attempt, different methods for drying and dehydrating plant materials have been tried to retain their colour and form for a very long period (Bhutani, 1990).

There are different types of drying techniques used worldwide. Some of the popular drying techniques are:

Air drying
Microwave oven drying
Dessicant drying
Vacuum drying
Freeze drying

Drying and preserving flowers and plant materials is a form of artistic expression that was very popular during the Victorian age and has once again gained popularity. There are many reasons for preserving plant materials, whether your interest is in drying flowers from an arrangement that has special meaning or preserving beautiful cut flowers, foliage, ornamental grasses, and plant materials from the landscape or garden. Dried flowers are used in arrangements, wreaths, swags, pressed art, and other decorations (Musgrove, 1998), (Datta, 2004).

The beauty and value of the dried flowers are that they can be kept and cherished for years, which survive the cold of winter and heat of summer. With growing

eco-consciousness, the use of more and more nature-friendly things like these come as a natural choice for decoration. The life of dried flowers varies according to the species, texture of their petals and total consistency of flowers. Dried flowers can be effectively used for making decorative floral craft items for interior decoration and commercial exploitation (Ranjan and Misra, 2002). Trinklein (2006) cited on the reasons to preserve flowers as Dried plant materials provide distinctive indoor decoration, arrangements made from dried materials are long lasting and require little care.

Flowers are an emblem of divine beauty, but unfortunately the joy is short-lived. Natural flowers, though the most exquisite gifts of all cannot capture the emotions for a long time. The lasting beauty of lowers can be enjoyed by preserving the flowers. The design process now involves taking real flowers apart to closely examine their structure and observe the details of the stamens, leaves and calyx. The painstaking attention to detail is necessary to ensure botanically-correct designs Verma, (2008).

Dyk (1998) reported that air drying was the simplest method to preserve. Kumar and Parmar (1998) found that air-drying in shade is applicable during dry season and summer for flowers such as Acroclinum, Helichrysum and Limonium.opined air drying as the most simple and cheaper method of dehydration, Datta (1999) The main drawback is that the process is weather-dependant. Ranjan and Misra (2002) opined that weather dependence and shrinkage of petals are the main disadvantages of air drying. Blue and yellow flowers retain their colour when air dried but pink flowers fade. Laliberte (2004) opined that flowers should be hung dried in a warm (not over 85 degrees) and dark place as light will fade flower colours. 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.

Bhutani (1990) found that flowers embedded in drying medium in a container and exposed daily to sun, resulted in rapid dehydration. Nataraj et al. (2004) reported that colour retention was better in the flowers embedded in sand and dried under shade, while it was poor in sand embedded oven dried. Among the different desiccants like silica gel, borax, sand, borax + sand etc., silica gel was found suitable for plumeria flowers by retaining their form and colour (Rani *et al.*,2000). According to Prasad *et al.* (2003) rose flowers appeared almost fresh when dried in silica gel, although the colour darkened. Colours that came out close to the original when dried in silica gel are white,

yellow, lavender and blue (non roses). Darker colours such as red, deep pink and orange tend to turn even darker.

According to Adiga *et al*. (2004) different drying methods like shade, oven and microwave oven with two different desiccants viz., sand and silica gel have a strong effect on the quality of Ixora singaporensis. Highest sensory score for appearance was recorded with microwave dried flowers embedded in silica gel, while appearance of shade dried flowers was poor. Among the different drying methods like sun, shade and hot air oven drying methods, oven drying proved better for its influence on quality parameters like retention of colour, shape, appearance and texture of marigold (Tagetes erecta) flowers (Kulkarni *et al.* 2004). White *et al*. (2002) reported that microwave oven dried flowers look fresher and more colourful than that obtained by other methods. After drying in the microwave oven, flowers must be left in the drying agent for a few hours known as setting time for getting good appearance and colour to the flowers. Nataraj *et al*. (2004), reported that of the three cultivars of annual statice (*Limonium sinuatum* L.) *viz*., turbo yellow, turbo carmine and turbo white studied, the flowers of cv. Turbo yellow dried in microwave oven embedded with silica gel scored highest for retention of colour, shape, texture and overall appearance.

Vacuum-drying (Orians, 1995) and conventional freeze-drying (prefreezing with liquid nitrogen) at low temperature (Lindroth and Koss, 1996) are previously recommended methods of preserving *Populus tremuloides, Salix sericea*, and *S. eriocephala* leaves. Unfortunately, vacuum-drying has been found to alter the carbohydrate content in the leaves of *Populus tremuloides*, with the result that the decrease in starch content is reflected by an increase in percent leaf dry mass for glucose (Lindroth and Koss, 1996).

Freeze-drying is a relatively new preservation process for the preserved plant material industry. It is the method that results in the most natural looking flower is freeze-drying. A blend of science and art, freeze-drying retains the shape and color of your flowers almost as if they are still fresh. The main advantage of freeze-drying is that it results in products that appear almost like the fresh originals. Freeze-drying has been rated as the best floral preservation method, available in the market today (Good Housekeeping Magazine, 1999).

Niguel (2002) stated that in January of 2002 Nature's Beauty™ purchased a "SandVac" machine. This is in addition to the freeze-dry machine, but it works on a different principle. After applying a pre-treatment, the flowers are immersed in a special, hygroscopic silica sand. The box with the sand and flowers is placed in the machine, which runs at an elevated temperature of approximately 45°C (112°F). A deep vacuum is drawn, and the flowers dry over a period of a few days. This process is particularly effective with certain types of flowers such as gerberas, daisies, tulips, some orchids and others. Other flowers such as roses are better preserved using the conventional freeze-dry process.

Truly Madly Deeply florists (2002) highlights there are several advantages of freeze-drying over other drying methods and they are that the petals remain the same size as they were when they were fresh, they retain all of their curves and shape, they retain their softness and whilst some colours do darken slightly, in the main, they keep all of their colour and subtlety of shading. The process renders them stain resistant and they are still biodegradable and wholly natural Beautiful and memorable flowers are easy to display and keeps well without being spoiled while retaining the characteristics of freshness. Freeze dried flowers preserved from special occasions, evoke the past, and leave us with sentimental thoughts and commemorate good times like weddings, anniversaries, births, retirement, to Mother’s Day and Valentine’s Day.

Chikayo, Masataka, Tetsuya et al. (2002) reported the comparative study on the optimum drying method of dried flowers for multipurpose use and the processing methods for making dried flowers as durable consumer goods and development of their applied products are desired to increase their demand. In this study, Little Mabels(Rosa L) have been dried in order to select the optimum drying method by using existing order to select the optimum drying method by using existing air-drying and latest drying methods such as a silica-gel drying with electric heaters, freeze-drying as well as vacuum-microwave drying. No shrinkage or change in morphology occurred in both silica-gel and freeze-drying because the samples were fixed during drying. Colour difference between before and after drying also increased in the greater rate of sample shrinkage, caused by the decrease in its moisture content. Flowers dried with silica sand are fragile so it is highly important to be very careful when removing them, the flowers will sometimes reabsorb moisture and wilt. Although the shape, size, and colour of freeze-dried flowers are similar to those of fresh ones, they are more fragile (Chen, 2000). To determine the best way to dry flowers, the Good Housekeeping Institute's

chemistry department tested four popular drying procedures: air drying; silica gel; cornmeal and borax, and freeze-drying It was reported that freeze dried flowers looked truest to life and will last the longest. (Good Housekeeping, 1999).

There are two big problems with conventional drying methods - First, it's difficult to remove water completely using evaporation because most of the water isn't directly exposed to air. Though it certainly slow down bacteria and enzyme activity, but won't stop it completely. Secondly, in the air drying process there is significant change in the shape, texture and composition of the material, in the same way that heat in an oven changes colour and texture.

Flowers already have perfect colour, beautiful shape, and their smell is pleasurable. Some flowers have petals with very distinctive shape, some have very distinctive colour, some have very characteristic texture patterns and some are characterized by a combination of these properties the parameters that distinguishes one flower from another can sometimes be their shape, sometimes their colour and sometimes distinctive texture patterns (Nilsback and Zisserman, 2006). Mostly it is a combination of these three aspects. They are colour, shape and texture. The challenge lies in finding a good representation for these aspects and a way of combining them that preserves the distinctiveness of each aspect, rather than averaging over them.

The dehydration process must be complete before the tissue is removed from its physical supporting medium. Failure to ensure this results in loss of shape and chemical reactions which ultimately result in tissue discolouration. In the case of flowers, colour retention is far easier than in the case of green leaves because chlorophyll is a highly reactive and therefore sensitive substance. Flower pigments have evolved under circumstances which involve light reflection rather than light absorption and in this sense are relatively chemically inert by comparison with chlorophyll. The problem therefore, is one in which dehydration must be effected in such a way as to retain original colour and shape and then treat the tissues so that they will last. The treatment solution should also contain buffers and the like to modify the biologically harsh effects of the primary chemicals

2.5 Floral Freeze Drying Technology and Process

After years of research and development, Freeze Dry Company introduced the amazing concept of freeze-drying flowers in 1981. Producing a dried flower with the beautiful colour and shape of fresh flowers has been a phenomenon that has taken the industry by storm. Endless creative and business applications for the freeze drying process have been discovered by floral entrepreneurs world-wide, making freeze dry the hottest business opportunity in the floral and crafts industry Wedding flowers, valentine bouquets, or any special event flowers can be freeze dried for a lifetime of beauty

Kathy (2010), the founder of Memories & Memorials disclosed that proper floral freeze-drying doesn't produce flowers that are brittle and lifeless as traditional or silica gel drying methods. Flowers will retain the shape and colour of the actual fresh flower. It will not be flat or pressed. There are very few experts in the floral freeze dry industry because the equipment is expensive, requires extensive training to operate, knowledge about flowers, and floral design are required

Christie (2010) the founder of Florage, specializing in freeze dried flowers and flower preservation stated that the freeze-drying process is an innovative vacuum process that takes approximately four weeks depending on the flower. The freeze-drying machine drops the temperature to a –20°F then it slowly returns the flowers to room temperature over the four week period. This slow preservation process allows the flowers to retain their original form, while the colours become enriched. Each flower is freeze dried separately to ensure an aesthetically pleasing shape. The individual flowers are labelled and placed in the freeze-dry machine, carefully, to avoid any bruises to the flowers. The stems are removed to enable for the bloom to stand upright. Each freeze dried flower is then dipped individually in a solution that seals the flower and allows them to be soft and pliable. The dried flowers are allowed to dry for a minimum of 36-48 hours. This additional process helps the flowers to last indefinitely. Freeze-drying flowers is a very labour intensive and time consuming process. However, this innovative technique allows your special flowers to last indefinitely.

According to Mnerie (2008), Barley (2009) and Dalgleish (2010), the basic idea of freeze-drying is to "lock in" the composition and structure of the material by drying it without applying the heat necessary for the evaporation process. Instead, the freeze-drying process converts solid water -- ice -- directly into water vapour, skipping the liquid phase entirely. Dehydration activity arrests the forces of natural decay in many ways. Micro organisms are successively inhibited from growth. Freeze-drying flowers

for preservation utilizes highly specialized, expensive equipment, which uses mechanical refrigeration and a vacuum system.

Jennings (2001) an expert in vacuum technology and lyophilization stated that the freeze drying process includes

1. Freezing: The product is frozen. This provides a required condition for low heat drying.
2. Vacuum: After freezing, the product is placed underneath vacuum. This enables the solidified well-off in the product to burn but flitting by the glass phase, a routine well known as sublimation.
3. Heat: Heat is practical to the solidified product to accelerate sublimation.
4. Condensation: Low-temperature condenser plates mislay the vaporized well-off from the opening cover by converting it back to a solid. This completes the separation process.

Freeze-drying is the removal of water from an object while the water is in its solid state (ice crystals), otherwise known as sublimation.

- Sublimation is the vaporization or distillation of water directly from its solid state to its vapor state, without passing through its liquid state.
- Sublimation takes place when the vapor pressure of the ice on the surface of the specimen (flower) exceeds the vapor pressure surrounding the specimen.
- A vacuum of 100 millitorres, less than the vacuum of space, is created in the chamber holding the flowers.
- A separate condensation chamber starts at - 25°C and it is to this lower temperature that the sublimated water vapor is attracted, where it collects as ice on the chamber's sides.
- During the next 7-10 days weeks the floral chamber's temperature is slowly raised to 20°c while the condensation temperature goes even lower, reaching -50°c.
- The ice collected in the condensation chamber needs to be removed several times, but once it stops forming the process is completed.

- The final results are flowers that look fresh but will last for years with proper care. The process renders them stain resistant and they are still biodegradable and wholly natural.
- Freeze drying is the most perfect method of preservation of flower. Most botanical items (flowers, foliage etc) can be preserved without change in shape, color, or fragrance
- There are several advantages of freeze-drying over other drying methods and they are that the petals remain the same size as they were when they were fresh, they retain all of their curves and shape, they retain their softness and whilst some colours do darken slightly, in the main, they keep all of their colour and subtlety of shading.

When considering freeze-drying of any product, one must determine the proper dehydration conditions, including parameters such as freezing time and temperature, vacuum-drying time and temperature, and pre-processing treatments. Unfortunately, optimum freeze-drying procedures have been determined for very few products, including flowers. Processors of freeze-dried flowers often consider specific processing information proprietary because shortened processing times translate into more efficient use of equipment and greater profitability.

Chen, Karen, Gast *et al.* (2000) reported the effects of different freezing times and vacuum-drying temperatures on colour, moisture content, and stem and petal strengths of roses and carnations. Vacuum-drying temperatures had more effect on the flowers than freezing time. Lower vacuum-drying temperatures resulted in flowers with colour closer to fresh and control flowers, while higher vacuum-drying temperatures resulted in lower moisture contents and stronger/stiffer petals but more changes in colour.

The initial cost of equipment investment, electrical energy consumption, and equipment maintenance are relatively higher than those for other drying methods. Freeze-dried flowers are of sufficient value such that they justify the substantial cost of freeze-drying.

Figure 2.1. Commercial Floral Freeze Dryer

2.6 Treatments for preserving inherent qualities of flowers in floral Freeze Dryer

When preserving sensitive biological materials, the main enemies are water, oxygen, and heat. Water is a powerful solvent, and is required for many chemical reactions, including enzymatic breakdown. Oxygen causes adverse chemical changes through oxidation, which is why anti-oxidant compounds are so popular. Heat can decompose or breakdown ingredients by itself, while at the same time accelerating other chemical changes, including enzymatic breakdown and oxidation. Since flowers and foliages contain more water, dehydration is necessary for getting dry flowers (Pebley *et al*, 2004).

Other than those in trade journals and popular literature, few references define the requirements of freeze-drying flowers. Wilkins and Desborough (1986) froze chemically sprayed flowers at -80^0C for 12 h and then dried them under a vacuum of less than 100 mm Hg for up to seven days. The results showed that the chemicals used (Glycerin, clove oil, Ethylene glycol, Dimethylsulfoxide, and liquid detergent) failed to render the petal tissue flexible after freeze-drying. They found that the following freeze-drying times for baby's breath, Gypsophila paniculata, 4±5 days; for carnations, Dianthus caryophyllus, 7 days, and for roses, Rosa hybrida and snapdragons, Antirrhinum andreanum, 8±9 days. They also noted that the effect of freeze-drying on colour was dependent on the original color of the flower. Red and purple flowers

changed more in colour than white, pink, or yellow ones. For flowers, colour is the one of the most important aesthetic characteristics.

Reddy and Kumari (2010) explored the feasibility of preservation of flowers in freeze drying process. Pre-treatment was found to be the crucial step for retaining the colour in freeze-drying process. A small bench top freeze dryer with an ice capacity of 1.5 Kg suitable for all freeze drying applications was used for the study. Though final products retained colour, it was found that the time gap in shifting the frozen flowers from deep freezer to freeze dryer and lack of control to regulate vacuum pressure during drying process resulted in over-dried flowers.

When the Freeze Dried Flower Industry began in 1988, the flowers were fragile, shattered easily, and had a tendency to change colour. These problems have all been addressed through chemistry. The pre- and post- treating chemicals used today meet the needs for colour stabilization, durability, and longevity in freeze dried flowers. Use of floral preservative is the most economical and practicable method for extending the post-harvest life of cut flowers (Salunkhe *et al.* 1990). For many years, floral preservatives have been acidified and have usually included biocides to inhibit bacterial proliferation (Nowak & Rudnicki, 1990). Flowers remain fresh longer if they are placed in a suitable floral preservative (Nowak and Rundnicki, 1990].

Several preservatives/chemicals i.e. silver nitrate, aluminium sulphate, cobalt sulphate, 8-hydroxyquinoline sulphate, boric acid, citric acid, ascorbic acid, sucrose etc. were used in different formulations and combinations to enhance the vase life of tuberose . Gibberellic acid has also been shown to increase the vase life of cut flowers by preventing leaves from yellowing early (Funnel and Heins, 1998).

Sierra and John (1982), opined that process for preserving substantially any variety of flower while retaining the natural colours thereof, in which the flower is immersed in an essentially water-free composition comprising of at least one dehydrating alcohol, a carboxylic acid, a urea-containing compound, an alkaline citrate, and zero to an effective amount of at least one of a Silicone fluid, a Silicone resin, an alkaline Formaldehyde Sulfoxylate, Aluminum or Magnesium Sulphate and Cupric or other transitional metal sulphate for sufficient time to dehydrate the flower, said composition also containing a sufficient quantity of at least one compound in the group consisting of an alkaline phosphate, a lower carboxylic acid and phenol so as to ensure

that the composition has a pH in the range 5-7. Following immersion the flower is dried and, if desired coated with a silicone resin.

Sierra (1988) studied on pre-treatments and reported that pH control of the formulation is necessary for consistent results and preferably the pH should be in the range 6.0-6.5. pH control can be achieved even without the use of an alkaline phosphate buffer provided a sufficient quantity of a lower carboxylic acid such as Propionic acid and/or Phenol is added. Sodium or other alkaline Formaldehyde Sulfoxylate is optionally added to the formulation for its bridging properties and is particularly useful in the treatment of white blooms. A carboxylic acid is employed primarily as a colour preservative for red, pink, yellow and white. Although suitable acids include Tartaric acid, Salicylic acid, Carboxylic acid and Citric acid is preferred. Too low a concentration causes the colours to appear faded, especially in red flowers. Too high a concentration can cause burning or colour changes, particularly in the green portions of the flower. Thiourea is a preferred urea-compound is essential constituent to prevent loss of pigments from the blooms and, used together with citric acid and sodium citrate, it increases the efficiency of those chemicals and prolongs the active life of the composition. Insufficient Thiourea or other urea-containing compound causes the colours to appear dead and lacking in their original fresh beauty, and some colours may even change completely, as for instance a blue orchid may turn a sickly red or pink.

A study by Sierra and John (1982) revealed that Aluminum Sulphate is an optional constituent in the formulation which appears to affect the overall quality of the colours of the blooms. Too much Aluminum sulphate (more than 100% excess) may cause spots resembling burns on red and blue petals. Magnesium sulphate may also be employed but tends to be hydroscopic. Sodium or other alkaline citrate is added as a colour preservative for blue, purple and orange blooms and is used in conjunction with Thiourea. Excess sodium citrate does not appear to affect blue, purple or orange blooms but red and pink blooms are adversely affected. Cupric or other transitional metal (Fe, Ni) sulphate is an optional constituent added not only to fix the colour of the blooms but also to draw away moisture which gathers at the bottom of the treatment tank. Silicone fluid below about 30 ml./l. results in inferior products, from the point of view of biological stress, but an excess has no effect and merely increases cost of formulation

Thomas (1999) evolved a process for preserving cellular structures includes the steps of pre-treating the structures with an aqueous polymeric water solution, drying the

structures and then post-treating the structures with an organic solvent, non-water-base solution. Once the structure has been treated with the pre-treatment solution, the specimen is allowed to sit for a predetermined period of time in order for the active ingredients of the solution to penetrate the surface area of the specimen. The specimen is then preferably freeze-dried.

Thomas (1999) also opined that the amount of each chemical required depends upon the type of cellular material being treated. Furthermore, the chemical formulation must take into consideration the material treated, the ease of formulation, the process of application, the toxicity to the environment, and the cost of formulated materials as well as the overall final market value of the finished product.

Sakamoto (2010) worked on method for producing preserved flower and processing solution and found that better results can be obtained by subjecting the fresh flower to pre-treatment of immersion in the solvent or dispersion solvent included in the processing solution and then subjecting the resultant flower to the immersion treatment in the processing solution. This method includes immersing a fresh flower in an alcohol such as methanol, ethanol, or isopropanol to remove water such as the tissue water from the fresh flower and then immersing the resultant flower in a polyalcohol solution, such as polyethylene glycol, used as the preservative solution to replace the tissue water with the preservative solution. With this method, the conditions of the processed preserved flower can be satisfactorily maintained. However, the original flower colour is lost during the process of removing the tissue water, and therefore the flower must be coloured in the process of replacement with the preservative solution. Accordingly, the original natural colour of the flower cannot be retained by this method. Therefore, it is difficult to process flowers such as roses with two colours, for example, including red and yellow, to produce preserved flowers.

Sakamoto (2010) reported that preferably, the pH of the pre-treatment solution or the processing solution is adjusted using Acetic acid, Oxalic acid, Ctric acid, Formic acid, Amino acid, Hydrochloric acid, Sodium hydroxide, Sodium carbonate, Sodium hydrogen carbonate, Sodium hypochlorite, a phosphate such as Disodium phosphate or Potassium dihydrogen phosphate, a Sulfate, a Potassium glycerin solution, or a mixture thereof. A preferred pH is an optimal pH for a fresh flower used, and it is preferable that the solutions have a buffering action. For example, good results are expected when pre-treatment and processing solutions having a pH of about 2 to 3 are used for red

flowers. Preferably, blue flowers are processed in a pH range higher than the above range. A colour close to the natural flower colour can be retained when a suitable amount of an inorganic salt such as Sodium Chloride, Potassium Chloride, Sodium Sulfate, Potassium Sulfate, Sodium Phosphate, Potassium Phosphate, alum, or soda ash or an organic salt such as Sodium Acetate, Sodium Oxalate, Potassium Oxalate, Sodium Tartrate, Potassium Tartrate, or Sodium Succinate is added to the pre-treatment solution or the processing solution. Preferably, such a salt is added in an amount of about 1 to 5%.

Sellegaard (1995) stated that preferably, the pH of the aqueous solution is kept in the range of from 3 to 9, preferably about 7. explain However, even plant material preserved by the method of the present invention can undergo colour fading on prolonged exposure to sunlight. For this reason, the colour fade of the preserved plant material is preferably reduced by including in the aqueous solution a dissolved transition metal salt, zinc salt or aluminium salt. Any colour leaching can be further reduced by adding a colour fixative compound to the aqueous solution. Preferred colour fixative compounds are aluminium or magnesium salts, preferably in an amount of 0.01% to 3% by weight of the aqueous solution. The method of the present invention preferably further comprises the step of dipping the plant material in an aqueous solution or suspension of one or more polymers, followed by drying to provide a layer of polymer on the surface of the plant material.

Louise and Jennings (1997) worked on methods of preserving plant material and found that the thin layer of the polymer helps to maintain the structure and flexibility of the plant material and, most importantly, substantially prevents shrinkage of the plant material on drying. The thin layer of polymer also inhibits saprophytic degradation of the plant material. This method is found to be particularly suitable for preserving cut flowers. The aqueous solution or suspension can be an emulsion of one or more polymers that are not themselves soluble in water, preferably one or more polymers, a cellulose derivative, a starch derivative, a natural gum, an alginate and polyvinyl pyrrolidone, polyvinyl acetate or polyvinyl alcohol. More preferably, the aqueous solution or suspension comprises 5-15% w/v of carboxymethyl cellulose, 4-10% w/v of polyvinyl acetate, and a surfactant. Good results can also obtained by replacing the polyvinyl acetate with polyvinyl alcohol.

Jain (2011) stated that Vinyl Acetate- Ethylene Emulsion (EVA Emulsion) is a copolymer of vinyl acetate with low ethylene content having been developed as a powerful adhesive base, which offers the following special characteristics like initial adhesive strength, high wet tack, good creep resistance, water resistance, alkali resistant, good thickening response, and safety in operations. EVA Emulsions can be used as coatings and as adhesive for bonding. Coating gives clear and flexible films gives protection from direct sun light and it is resistant to yellowing colour on ageing effect. The main applications are as follows heat resistant (Up to 90°C), free from solvents (Water based), no smell, excellent bonding strength, no crack or unglue under normal conditions, excellent aging-resistant performance, environment friendly and economical to use.

Toshio *et al* (2005) worked on treatment method for preservation of plant leaves and reported that a treatment method for preservation of plant leaves wherein the plant leaves are immersed in a dehydrating solvent consisting of acetone and ethyl alcohol to replace the tissue water and remove chlorophyll in the leaves by the dehydrating solvent. Thereafter, the leaves are immersed in a permeating solution containing polyethylene glycol and acetone for allowing polyethylene glycol to permeate the leaves for replacing the dehydrating solvent. Thereafter, the leaves are dyed with a colouring matter.

Tandler (2010) found that dipping a cut flower in an acrylic emulsion containing up to 5 % wt of acrylic-based material selected so as not to confer any unpleasant odour to the product, together with suitable surfactants, substantially increases the storage time of the flower product. It turns out that a composition according to the invention solves the above mentioned problems associated with long term storage and long transport, extending the shelf life of the plants by a number of weeks, while keeping the cut flowers attractive, and while avoiding any unpleasant odour due to the used materials. The invention provides an acrylic emulsion for applying onto the plants by a dipping, coating or spraying process. On drying, a thin film of a few microns thickness is formed, acting as a barrier, which slows the rate of water loss. The film further protects the plant surface, and inhibits the development of the various plant pests and diseases. In a preferred embodiment of the invention, specific additives enhancing said protective effect are added to the acrylic emulsion. Such additives may inhibit microbial growth or deactivate ethylene. Applying said acrylic emulsion on the surface of a plant followed

by drying, leads to the formation of a polymeric layer. The polymer preferably has some of the following properties, combined according to specific applications and needs.

Masaki and Takahiro (2009) evolved an easy and simple procedure for preserving a cut flower, whereby the cut flower can maintain qualities similar to those of the natural state for a long period of time, and a method for manufacturing a processed cut flower that can maintain qualities similar to those of the natural state for a long period of time. The method for preserving a cut flower by replacing the tissue fluid of the cut flower by a preservative solution includes the steps of:

(1) A first replacement step in which the tissue fluid of the cut flower is replaced by a hydrophilic organic solvent; and

(2) A second replacement step in which the hydrophilic organic solvent having replaced the tissue fluid in the cut flower is replaced by the preservative solution of an organic solvent that has an affinity for the hydrophilic organic solvent and is nonvolatile or hardly-volatile.

Thomas (1999) researched on Preserved cellular structures and stated that the pre-treatment solution is a water-based solution so as to prevent damage to the freeze dryer during the freeze-drying process. It is for this reason that a standard petroleum-based solvent solution for pre-treatment is unacceptable. The pre-treatment solution preferably includes: (a) at least one monohydric alcohol; (b) at least one component selected from a group comprised of lower carbon- chained carboxylic acids; (c) at least one of a group comprised of antioxidants; (d) at least one of a group of sequestering agents; (e) at least one of a group comprised of humectants; (f) at least one from a group of organic acids, namely, a group of organic acids that easily disassociate in water, giving up a hydrogen ion to thereby lower the pH with a pK1 range from 2.0 to 5.5 (g) amines for use as buffers; (h) transitional metallic salts; and (i) at least one component from the groups of sulfate, phosphates, nitrates and chlorides with stable equilibriums in the pH range from 1.0 to 7.4.In the preferred embodiment, the composition includes sequestering or chelating agents selected from the group consisting of Ethylene diamine tetracetic acid and phosphoric acid, and mordant reagents which are preferably metallic salts selected from the group consisting of salts of Ammoniums, Phosphates, Sulfates, nitrates and chlorides.

The "exchange medium" used in the present inventions is normally one or more monohydric alcohols containing 1-6 carbon atoms. Such alcohols, particularly ethyl alcohol, isopropyl alcohol and tertiary butyl alcohol are known to have considerable dehydration properties preservative elements of the solution fall into three broad categories. Firstly as a biological or tissue preservative it has been found that lower carboxylic acids such as Formic acid, Acetic acid, or Propionic acid, or mixtures thereof are effective. Secondly, as an environmental fixer, i.e. an agent which will give "body" to the preserved tissue and provide resistance to "weathering" it has been found that a dihydric alcohol such as glycol, and more particularly ethylene glycol, or a trihydric alcohol such as a glycerol (1,2,3-propanetriol) or mixtures thereof are highly effective. Thirdly, although not an essential ingredient, it is usually desirable to include a biological fixative the most common of which is formalin although other fixatives may also be used. The fourth group of chemicals are generally referred to herein as "buffers, mordants and modifiers" and include citric acid, sodium phosphate dibasic, magnesium sulphate, cupric sulphate, chrome alum, and sodium sulfite and mixtures thereof in relatively small proportions.. Some chemicals appear to act as mordants while others are buffers not only for pH but also for osmolality. The amount of each chemical required depends upon the type of leaf being treated, the "exchange medium" being used and other factors. While not considered critical it has been found that best results are obtained when the pH of the treatment bath is maintained in the range 6-8 i.e. substantially neutral. Other minor ingredients may also be added as required. For example, a small amount of salicylic acid has been found beneficial to natural colour and in instances where the specimens are infected with fungus growths and the like the use of a fungicide such as Zephiran (benzalkonium chloride) has been found useful

Ito *et al.* (2007) reported on the methods for preserving fresh flowers with natural pigments and texture. It was stated that petals were dehydrated by various dehydration treatments, and then petal physical properties were determined by observing the petal sections and epidermal cells under a microscope. Most pigments leached out of the petal, but some diffused and were retained in the petals of a preserved flower. Although pigments were lost in preserved flowers prepared by the conventional methods, it was possible to prepare processed flowers with natural pigments similar to those of fresh flowers using appropriate solvents. Appropriate solvents were chosen from different normal monohydroxy alcohols and polyols on the basis of their structural formula. The results show that processed flowers with natural pigments and texture can

be made using normal monohydroxy alcohols and lateral chain diols. Such processed flowers are similar to fresh flowers because of their natural pigmentation and textures are retained.

Spraying the dried flowers with a clear plastic spray will prevent them from absorbing water during humid periods and prevent dust from sticking and discolouring the petals (Gouin, 1994). Gordon (2004) opined that covering dried roses with a clear plastic spray, acrylic or lacquer will preserve the colour and make them more durable and moisture resistant. Also dipping or painting the petals with a thin coat of melted paraffin wax at a cooler temperature will preserve the blooms.

The preserved flowers are flowers obtained by replacing the water contained in the tissues by a preservative solution. Because preserved flowers have qualities (shape, texture, colour, etc.) very similar to those of the natural state, as compared to conventional dried flowers, preserved flowers are often used, as a unique flower material, for wedding bouquets and for flower arrangements for decorating the entrances and living rooms of ordinary households. Preserved flowers can be used when there is non-availability of desired fresh seasonal and exotic flowers and foliages all round the year in all places

A wide variety of markets exist for freeze- dried flowers. Also, their own unique characteristics are opening up entirely new markets. Many value added products can be made from dried flowers such as collages, flower pictures, flower balls, greeting cards, covers, pomanders, festive decorations, bouquets and wreaths, sweet-smelling pot pourries etc. (Raghupathy *et al*., 2000) stated that retail Florists, Gift and accessory shops, Furniture stores and Department stores can be a good market. Freeze dried flowers are gaining in popularity to be used in wedding celebrations. Bouquets that were special for anniversary, graduation, birthday, etc. can be processed and packed in glass domes, plexi display cases or shadow boxes. For window display seasonal arrangements can be produced in advance for departmental stores etc. Hotels and Office Parks, these kinds of establishments understand the positive power of flowers. The product is good to display in lobbies, guestrooms, banquet rooms and restaurant and banquet facilities. Freeze-dried Potpourri is beautiful; consequently it is worth the most.

2.6 Packaging methods for preserved flowers

Dried materials in storage may occasionally be attacked by one or more household insects such as museum beetles, silverfish, cockroaches or others closely related to them. As they chew on the soft tissue of the plant centers, flowers may shatter and fall apart (Trinklein 2006).

Dry flowers are fragile and require careful handling.. Much has been researched and written on the techniques and procedures for cutting/harvesting, packaging and storage of flowers. If these are improperly managed, the quality and durability of the product will be compromised. Since Dry flowers are made up of cellulose materials of plant origin, it invites lot of pests. They are hygroscopic in nature, if allowed to absorb moisture, problem of mould infection will occur.

Bhutani (1990) recommended storage of dried plant material in desiccators or glass or plastic jars in which the silica gel crystals are kept. Flowers dried using silica gel will sometimes reabsorb moisture and wilt; therefore it is recommended that the flowers should be stored and displayed in a closed container to keep out moisture (Sell, 1993). Smith (1993) suggested storage of flowers dried with sand in a strong carton to protect the petals from breaking. He also recommended to display the silica gel dried flowers in a closed container to keep out dust and high humidity. Dried materials should be stored in a dark, dry airtight container. A layer of tissue paper should be placed between flowers to reduce breakage.

Silica gel crystals should be kept at the bottom of the storage containers like desiccators, glass jars or plastic jars to prevent the dried plant material from spoilage and for their future utilization (Bhutani, 1995). Bull (1997) claimed that dried flowers could be stored in a covered wicker box or cardboard box with holes on top and sides. The materials should not be stored in plastic covers and boxes. The flowers such as Larkspur, Hydrangea or sweet Anni could be made durable by using a hair spray over them and wrapped loosely with tissue paper or newspaper and laid flat in the container kept in a cool dry place.

Champoux (1997) suggested that dried flowers could be stored in cardboard boxes after covering the bunches with loose tissue papers. For flowers dried by silica gel method, some silica gel crystals should be sprinkled at the bottom to avoid moisture build up. Wrapping with plastics caused moisture build up and ruin the flowers.

Thomler (1997) suggested that well dried flowers could be stored in cardboard boxes in a cool dry place. The dried material had to be held firmly to avoid breakage. According to Datta (1999) since dry flowers absorb atmospheric moisture and lose their shape, they should be stored in moisture proof containers like glass desiccators, tin boxes, cartons wrapped with plastic sheet or wax paper wherein silica gel crystals are kept at the bottom. Storage containers should be dust free and it should be protected from light and direct sunlight to preserve colour.

Rengasamy *et al*. (1999) reported that selection of proper packaging, giving proper cushioning and use of moisture barrier packaging materials are of prime consideration in dry flower industry. Boxes should be free from insects since they chew the soft tissue and flower petals shatter making the material unsuitable. Yan (1999) recommended the wrapping of dried flowers in newspaper and placing them in a cardboard box. The box should not be stored in an unusually damp or very dry place. A few moth balls can be kept to protect from small rodents and insects. Trinklein (2000) recommended various control measures against the household insects which move into the boxes during storage. Occasional checking of the box for insects and using naphthalene flakes are suggested. Plastic sandwich bags, regular or zip lock, are also good storage devices (Ferguson, 2001). Singh *et al*. (2003) reported that moisture content in dried flowers of Zinnia linearis influences flower quality and longevity. A range of 8 to 11.5 per cent moisture content in the dried flowers provided optimum drying with good quality, firmness and showed good keeping quality above six months.

Dried roses should be stored in sealed, tight containers such as cookie tins or tupper ware or in plastic bags where in small amount of silica gel should be kept. To store the dried flowers for later use, seal them in airtight containers such as tins or plastic boxes sealed with masking tape or sealed cardboard boxes enclosed in airtight plastic bags (Plomaritis, 2004). Dried flowers should be treated with a suitable biocide (insecticide and fungicide) and packed in waterproof containers.

According to Barley (2009), storage of Lyophilized products are extremely hydroscopic and they must be sealed in air tight containers following freeze drying to prevent rehydration from atmospheric exposure.

Review of various dimensions of flower preservation lead to an understanding of intricacies in the art. Flower preservation is art and science especially with Freeze-drying technology. It is a relatively new preservation process for the preserved plant

material industry. The main advantage of freeze-drying is that it results in products that appear almost like the fresh originals. Treating flowers, prior to drying process in floral freeze dryer results in physically the original flower.

Chapter III

MATERIALS AND METHODS

This chapter provides the detailed description of the procedure adopted for conducting the research on "Effect of Selected Preservation Treatments on the Quality of Exotic Flowers in Floral Freeze Dryer" after reviewing the relevant literature and formulating the objectives of the study. Methodology adopted for this study is presented under the following headings:

3.1 Research design
3.2 Location of study area
3.3 Selection of exotic flowers
3.4 Selection of Equipment
3.5 Selection of treatments
3.6 Selection of tool for evaluation
3.7 Collection of data
3.8 Statistical analysis and Interpretation

3.1 Research design

The research design is the planned structure and strategy of investigation. In other words it is the overall scheme of program of research. Research designs are planned to obtain answers to research questions and analysis of variance. It is a

systematic activity directed towards discovery and the development of an organized body of knowledge and systematic application of the scientific method to the study of problems (Creswell, 2003). The experimental research design was adopted in this investigation to explore the Effect of Selected Preservation Treatments on the Quality of Exotic Flowers in Floral Freeze Dryer. Experimental research, although very demanding of time and resources, often produces the sound evidence concerning hypothesized cause-effect relationships.

3.2 Location of study area

Absolute facility for conducting laboratory experiments is very essential for the success of research. Hence, the Department of Resource Management and Consumer Sciences, College of Home Science, Hyderabad, Acharya N.G.Ranga Agricultural University, which has a full-fledged laboratory with suitable equipment was selected for conducting this research. This department has been involved in a State Plan Research Project on Freeze dried Flowers in Floral Freeze Dryer for the past two years, hence has a full-fledged laboratory with essential equipment.

3.3 Selection of Exotic Flowers

Breathtaking exotic flowers and plants add that extra special touch to gardens, homes, and all occasions - weddings, celebrations, banquets, as well as solemn occasions. As the objective of the research was to explore the effect of selected treatments on the quality of exotic flowers in Floral Freeze Dryer, the exotic flowers with brilliant colour and shape were selected for the study through purposeful sampling with following criteria.

- Those available with florist in Hyderabad city of Andhra Pradesh
- Blooms should be available in market at least for 3-4 months in a year.

Keeping these criteria in view, five types of exotic flowers viz., Bird of paradise, Anthurium, Statice, Asiatic Lily and Orchids were selected for the study (Figure 3.1). Physical characteristics of these flowers are given in Table 3.1.

Table 3.1. Physical characteristics of selected Exotic flowers for the study

Flower	**Form**	**Texture**	**Colour**	**Fragrance**
Anthurium	Heart-shaped flower and an oval waxy 'tail' that rises out of it.	Leathery and glossy petal	White, pink, red, coral, green, lilac and some multi coloured	Slight, sweet scent
Bird of paradise	A unique creation in nature. The petal jet out to form a crane-shaped calyx.	Leathery stiff petals	Combination of blue and orange petals	No scent
Asiatic Lily	4-5 large elaborate, starry, trumpet shaped flowers	Thick but pliable. glossy petal	Red, white, pink, peach, striped and colored edged petals	Faint, sweet scent
Orchid	Flat-faced petals and sepals of equal size and strap or cylinder shaped leaves	Stiff, velvety and glossy petal	White, green, red, orange, burgundy, yellow and brown	Spicy, peppery scent
Statice	Cluster of calyxes with small flowers on the inside and stiff angular stems.	Thick but pliable, glossy petal	Yellow, white, purple, lavender or pink	No scent

Anthurium

Bird Of Paradise

Asiatic Lily

Statice

Orchid

Figure 3.1. Exotic Flowers Selected for the Study.

3.4 Selection of equipment

The equipment required for conducting the experiment and the purpose of it in research are given in Table 3.2.

Table 3.2. Equipment/Aid used for the study

S.No.	Equipment/Aid used	Purpose
1.	Chest cooler, Magnetic stirrer, Air blower, Scissors, Foam, glass bottles and chemicals	Pre-preparation
2.	Floral Freeze dryer, Floral trays	Freeze drying process
3.	Colour Scanner, Computer and Adobe Photoshop Software	Colour analysis
4.	Electronic weighing balance, Log book	Moisture analysis
5.	Camera, Log book	Physical observation and documentation of experiment
6.	Polythene covers, Zip lock pouches, Air tight plastic boxes, Display cases.	Storage provisions

Floral Freeze Dryer: A Floral freeze dryer (Figure 3.2a) developed by Delvac Pvt. Ltd that has the following systems for dehydration of flowers was used for conducting this research.

- A vacuum system to remove the air from the refrigerated chambers.

- A refrigeration system for the specimen chamber.
- A refrigeration system for the ice bank chamber.

The complete unit is sealed by the rubber gaskets on the doors. When the vacuum pump is started, the pressure will decrease in the system. Under freeze-drying conditions, water is changed from a solid state to a vapour state without going through a liquid state. Solid ice in the samples becomes water vapour in the specimen chamber. The difference in temperatures between the specimen chamber and the condenser causes this vapour to be drawn into the condenser. The vapour turns back into ice when it comes in contact with the cold condenser walls. If the temperature of the condenser walls is not cold enough excessive moisture may pass through the condenser and into the vacuum pump.

Floral Preservation process in Floral Freeze Dryer (Lyophilization) : The basic principle of floral freeze drying (Lyophilization) is the removal of water from frozen flowers as water vapour, and collection of this water vapour as ice in a condenser. The flowers are solidly frozen during the process, and under a deep vacuum, shrinkage is eliminated or minimized, and near perfect preservation result in. The process requires the flowers to be pre-treated and frozen in freezing chamber for a minimum period of 24 hours under -25ºC and then gradually the temperature is raised to stimulate sublimation (ice crystals changing directly to water vapour). Over a period of 7-10 days is required for all the water from the flowers to sublimate and go into a condensation chamber. The water vapour turns back into ice in this very cold (-40° C or lower) condensation chamber. Defrosting the condensation chamber removes moisture from the freeze drying (Lyophilization) system. When ice quits forming in the condenser the load is dry for removal and use.

Chest Cooler: A commercially available horizontal Chest Coolers which are used for cold storage foods was selected for storing flowers before treating them for freeze drying process. It has an automatic temperature control for maintenance of desired internal temperature (Figure 3.2b).

Electronic weighing balance: Moisture is the greatest enemy in dehydration process. In order to study the extent of loss of moisture in the light weight flowers, there is a need to use a weighing balance that has high precision. Hence an electronic weighing balance that can measure the mass to a very high degree of precision and accuracy was

selected to examine the change in weight of the flowers before and after freeze drying (Figure 3.2c).

Magnetic stirrer: Magnetic stirrer includes a hot plate for heating the liquid for quickly even blending and dissolving the solvents used for treatments (Figure 3.2d). It is a laboratory device that employs a rotating magnetic field to cause a stir bar immersed in a liquid to spin very quickly, thus stirring it. They are preferred over gear-driven motorized stirrers because they are quieter, more efficient, and have no moving external parts to break or wear out (other than the simple bar magnet itself).

Air Blower: Quick setting of treatment is an important step in freeze drying process. An air blower that allows excess moisture to evaporate is important equipment for this research. A commercial air blower was used for evaporating the excess liquid on the flowers (Figure 3.2e).

Floral trays: Floral trays of different sizes and shapes are used for stacking the pre-treated flowers (Figure 3.2f). Depending on the type of flower, different shapes of trays are used for complete drying of the flower. The shape of the tray determines the quality of the flowers.

Colour Analyser: Colour plays an important role in assessing the beauty of flower. A colour scanner was used to scan the predominant colour of the flower before and after freeze drying. With the help of computer and Adobe Photoshop software, the HSB values of the flowers were drawn from scanned pictures (Figure 3.2g). These quantified values of colours were used to assess the change in hue of flowers (Nilsback and Zisserman, 2006).

Storage Provisions: Storage can be sometimes challenging, especially because one wrong move can altogether ruin the preserved ones. In order to protect the preserved flowers, three different simple storage methods as suggested by Ferguson (2001) were used in this study viz., polythene covers, zip lock bags and air tight containers (Figure 3.2h).

Tools & Aids: Scissors, Floral foam, glass bottles, bowls and stirrer, were necessary for handling flowers during treatment process (Figure 3.2i). Scissors was used for trimming and cutting the stems of the flowers, while floral foam was used for supporting flowers while treating to hydrate them before placing them in the freeze dryer. Glass bottles

were used to store the pure chemicals and compound chemicals and glass bowls were used for dipping the flowers during the pre-treatment.

Data recording equipment: Digital camera was used to record necessary data, freeze drying process and document pictures of before and after effects of the treatments. A data log book is used to record the data related to the study (Figure 3.2j).

Figure 3.2a -Floral Freeze Dryer

Figure 3.2b - Chest Cooler

Figure 3.2c - Electronic Weighing balance

Figure 3.2d - Magnetic Stirrer

Figure 3.2e - Air Blower

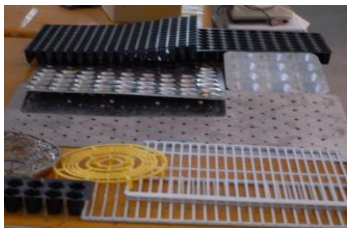

Figure 3.2f - Floral Trays

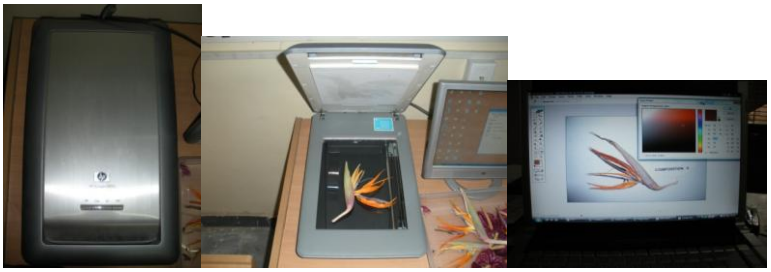

Figure 3.2g - Colour Analyser

Figure 3.2h -Storage Provisions

Figure 3.2i -Tools & Aids

Figure 3.2j -Data Recording Equipmen

Figure 3.2. Equipment used for the study.

3.5 Selection of treatments

Fresh flowers need preservatives to avoid their premature wilting which eventually fades out over a period of time**.** Freeze-drying is a process that retains pigment (colour) and structural parts (cells) and thus remains as fresh bloom for years. The pre-treatment with suitable water based chemical preservatives helps to retain colour, shatterproof and soften the flower.

A set of 14 different chemical solutions were identified (Figure 3.3.) through literature survey that was found to have influence on physical characteristics of flowers (Romero-Sierra, 1982). A standard solution is a solution containing a precisely known concentration of an element or a substance. These were tested on floral petals to study its effect to hold in colour and open the cell structure of the flower, as this enhances the water removal process during the freeze-drying process. The choice of chemical and salient physical characteristics are presented in Table 3.3

Table 3.3. Chemicals for treatment on flowers and Salient Characteristics

S.No.	Chemicals	Salient characteristics
1	Tertiary butyl alcohol	harsh dehydrant
2	1-propanol	mild dehydrant
3	2-propanol	mild dehydrant
4	Sodium phosphate	pH control or buffer
5	Sodium Formaldehyde Sulphoxylate	Colour fixative for selected colours
6	Citric acid	colour setting agent for selected colours
7	Thiourea	Colour preservative, prevents loss of pigments

8	Aluminium sulphate	Influences the overall quality of the colours of blooms as modifier and mordant
9	Sodium citrate	Colour fixative for selected colours
10	Cupric sulphate	Fixes the colour of the blooms but also to draw away moisture
11	Silicone Fluid	Protects from environmental factors like humidity and temperature
12	Silicone Resin	Withstand mechanical and environmental stresses
13	Phenol	pH buffer and aid in locking in the colours
14	Propionic Acid	Colour fixative, pH modifier

Figure 3.3. Solvents used for preparation of pre-treatments

Right:Basic five composition Middle:Water based polymer Left: Blend of basic and polymer

Figure 3.4. Blend of chemicals used for treatments of Exotic flowers.

The above chemicals identified for use in the present study were tested on selected flowers and were combined to form different compositions.

As the solvents reacted differently on different flowers these were blended into different compositions in the on-going research project. Out of these, five compositions were selected for treating the exotic flowers.

Composition I – A compound was evolved by blending three basic chemicals which were dehydrant, colour fixer and colour preservative. This composition included viz., t-butyl alcohol, thiourea and citric acid with the pH value of 5.0

Composition II – A compound was also evolved by blending three basic chemicals which were dehydrant, colour fixer and an alternative colour preservative. This composition was included t- butyl alcohol, thiourea and Sodium citrate, with the pH value of 5.5.

Composition III – A composition was evolved by blending less harsh dehydrant, colour fixer and colour preservatives. This composition consisted of 6 chemicals viz., t-butyl alcohol, 2-propanol, thiourea, citric acid, sodium citrate and propionic acid, with the pH value of 6.0.

Composition IV – A composition was evolved by blending less harsh dehydrant, colour fixer and colour preservatives and pH buffer. This composition consists of Tertiary butyl alcohol, 2-propanol, Thiourea, Citric acid, Sodium citrate, Propionic acid and Phenol, with the pH value of 6.5.

Composition V – A composition was evolved by blending less harsh dehydrant, colour fixer and colour preservatives with biological and environmental fixatives. This composition consists of all the chemicals identified for the study viz., t- butyl alcohol, 1-propanol, 2-propanol, Sodium phosphate, Sodium Formaldehyde Sulphoxylate, Citric

acid, Thiourea, Aluminium sulphate, Sodium citrate, Cupric sulphate, Silicone Fluid, Silicone Resin, Phenol and Propionic Acid, with the pH value of 6.5-7.

These were used on exotic flowers to explore the suitability of these treatments for retaining the inherent qualities of the selected flowers. Standardization is a process in which the value of a potential standard is fixed by a measurement made with respect

to a standard whose value is known. Preliminary trial experiments resulted in brittle and over dried flowers and this needed further improvement in treatment process.

Hence through literature survey, a polymeric compound that can produce softness, flexibility, gloss, stress-crack resistance, low-temperature toughness, water proof properties, no odour and resistance to Ultra Violet radiation was explored in the research project. This shatter resistant polymer was mixed with above five compounds 1:1 ratio to improve the shattering and dryness of flowers and tested on flowers.

3.5.1. Procedure for freeze drying process of flowers:

To explore the effect of the treatments, two sets of experiments were conducted using these five compounds

Experiment 1: All five basic compounds (BC)

Experiment 2: All five improved compounds (IC)

Duration of study: 7 Months. Preliminary trials experiments for testing the effect of chemicals on flowers were taken up between October – December and the trial and final experiments with flowers were taken up during January to March.

Pre-Preparation: Each flower selected for the experiment hydrated in tepid water of 10º C higher than room temperature, to regain health of flower. The vibrant colour of the fresh flower was analysed for through colour analyser to explore the hue and name of the colour. Also, weights of the flowers were recorded before commencing the pre-treatment process.

Pre-Treatment to flowers: Each flower was dipped individually in the selected solution in order to seal the flower. These were kept for evaporation in the floral trays before transferring to the freezing chamber. These trays were arranged in the preset freeze dryer which maintained -25º C.

Stage-1: Hydration & Pre-treatment

Stage-2: Arrangement of flowers in trays

Stage-3: Maintaining required temperature

Stage-4: Recording data day to day

Stage-5: Removal of flowers on completion of dehydration process

Figure 3.5.Floral Freeze Drying Process for Exotic flowers

Drying Process in Floral Freeze Dryer: The complete process of drying was monitored daily and freezer temperature was regulated by increasing the internal temperature by 5 degrees every day until it reaches the room temperature. The freezing chamber was opened after evacuating vacuum and the flowers were removed

Post-Drying Process: The freeze dried flowers were photographed, weighed and color scanned before placing them for evaluation by a panel of three experts. Freeze dried flowers were transferred into selected packaging containers. Three commonly used storage methods were selected viz., Polythene cover, Zip-lock vacuum bags and air-tight plastic containers.

Parameters for Evaluation of Flowers: Any flower irrespective of season or place of growth admired for its colour, form, texture, appearance and fragrance. Hence these four parameters were fixed as variables for evaluation.

3.5.2. Measurement of variables:

Colour: As the colour can be measured and perceived both quantitative and qualitative measurements were used. Quantitative measurement of colour was taken up with the use of suitable software and the qualitative assessment of changes in hue, value and intensity through physical observation were taken up by experts.

Quantitative measurement of colour: Each person also verbally defines an object's colour differently. As a result, objectively communicating a particular colour to someone without some type of standard is difficult. There also must be a way to compare one colour to the next with accuracy. The solution is a colour analyzer that explicitly identifies a colour. That is, a colour analyzer that differentiates a colour from all others and assigns it a numeric value.

Each colour has its own distinct appearance, based on three elements: hue, chroma (saturation) and value (lightness). By describing a colour using these three attributes, we can accurately identify a particular colour and distinguish it from any other.

For colour analysis, Adobe Photoshop software which has pantone colour system was used to study the deviation of colour from its original hue. Tristimulus colour parameters H, S, and B were measured at selected location on a flower.

The **HSV** (Hue, Saturation, and Value) model, also called **HSB** (Hue, Saturation, Brightness), defines a colour space in terms of three components:

- **Hue (H)**, the colour type (such as red, green). It ranges from 0 to 360 degree, with red at 0 degree, green at 120 degree, blue at 240 degree and so on.
- **Saturation (S)** of the colour ranges from 0 to 100%. Also sometimes it called the "purity". The lower the saturation of a colour, the more "greyness" is present and the more faded the colour will appear.
- **Brightness (B) (Value)**, of the colour ranges from 0 to 100%. It is a nonlinear transformation of the RGB colour space.

Hue is the actual colour. It is measured in angular degrees counter-clockwise around the cone starting and ending at red = 0 or 360 (so yellow = 60, green = 120, etc.). Saturation is the purity of the color, measured in percent from the center of the cone (0) to the surface (100). At 0% saturation, hue is meaningless. Brightness is measured in percent from black (0) to white (100). At 0% brightness, both hue and saturation are meaningless.

Colour analysis data is drawn from HSB values using Adobe Photoshop pantone colour system by comparing fresh and treated pictures of the flowers. HSB values of the freeze dried samples are compared with the fresh samples to know the change in its hue. Higher the value indicates that it has turned lighter than original and lower the value indicates that it has turned darker.

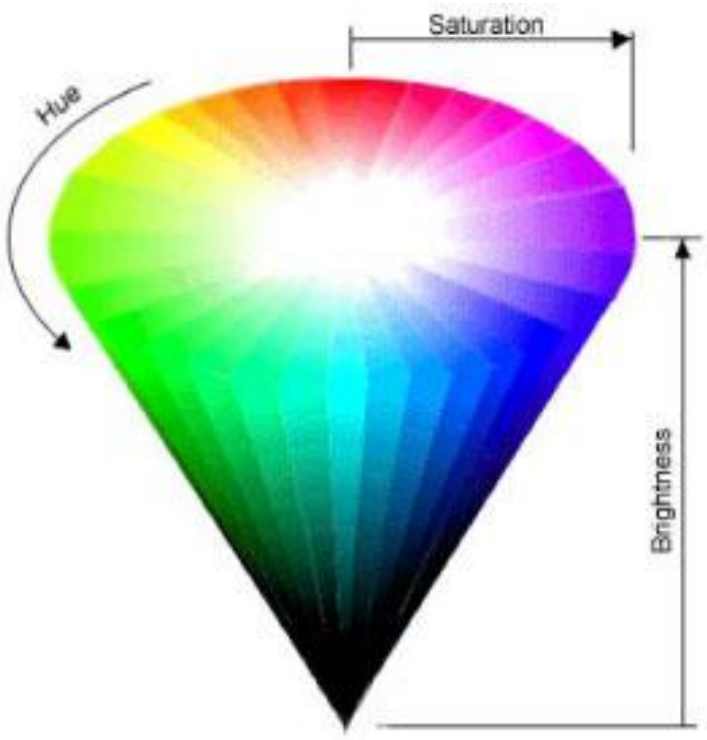

Figure 3.6. HSB Colour Model

Source: Alvy RaySmith(1978)

(http://www.createarevolution.com/blog/2008/04/30/visualizing-color/)

H - Hue value ranges from 0 to 360 degree

S - Saturation ranges from 0 to 100%.

B (V) - Brightness/ Value ranges from 0 to 100%

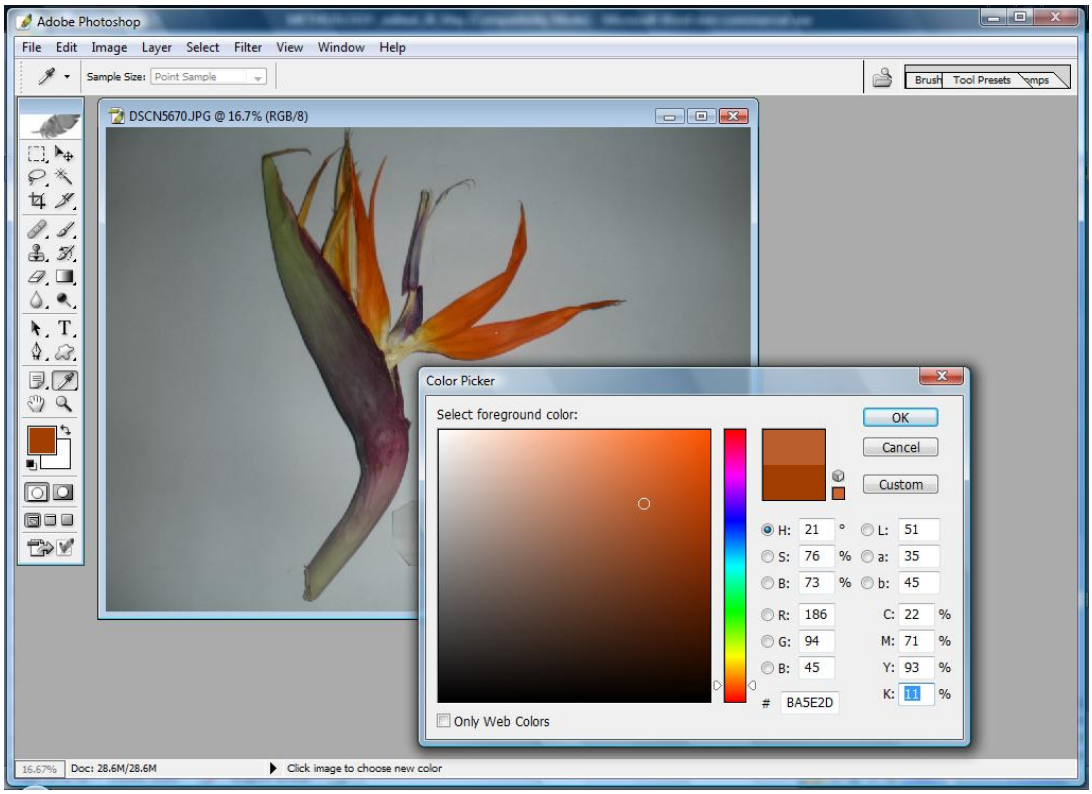

Figure 3.7. Assessing HSB values with Adobe Photoshop using Pantone colour system

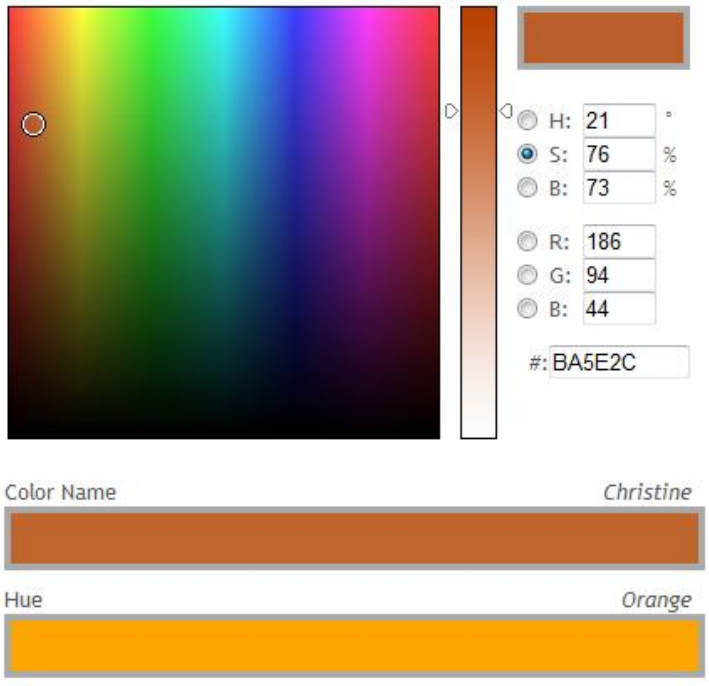

Figure 3.8. Software for defining colour name and hue with HSB values

Source : Daniel Fluck-Colblindor

Texture: As the pliability and feel of flower is influenced by moisture, change in weight of flower was quantitatively measured. The visual and physical tactile qualities of were perceived through physical observation and qualitative measured for softness, pliability, and suppleness.

Moisture analysis: For moisture analysis the percentage of weight loss of flowers was observed by weighing the flowers before and after the experiment by using the electronic weighing balance. This helped in knowing the extent of loss of moisture in the freeze dried flowers after evaporation in the freeze drying process. Loss of moisture due to drying was estimated by using the formula given below and expressed as percentage.

$$\text{Moisture loss (\%)} = \frac{\text{Fresh weight - Dry weight}}{\text{Fresh weight}} \times 100$$

Form and Appearance: These two variables which cannot be quantified were measured through physical observation.

Null Hypothesis: ***It was hypothesized that pre-treatment has no significant difference on the overall quality of freeze-dried exotic flowers.***

3.6 Selection of observation tool for evaluation

Pre-treated freeze dried flowers were evaluated by experts in two stages. The day after the completion of the drying process, flowers emerged out of both the experiments were labelled and displayed for the experts to evaluate the changes observed in the physical characteristics of flowers viz., colour, form, texture and appearance through physical observation.

The chemical composition that resulted in highest score for Freeze dried Anthurium, Bird of Paradise, Asiatic Lily, Orchid and Statice flowers were chosen as reference flower, and these were produced in large quantity, for assessing the effect of selected packaging methods. Flowers were stored for one month duration in polythene covers, zip lock bags and air tight containers. These flowers were once again evaluated

by the experts after a period of one month to explore the changes in flowers through physical observation, for assessing the keeping quality in different storage methods.

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For physical observation of qualitative parameters, an observation tool (rating scale) was developed (Appendix A and B). The parameters taken for evaluation in the rating scale were the colour, texture, form and appearance.

- Colour : 3 qualities - Change in hue, value and intensity
- Texture : 3 qualities - Change in feel, pliability and suppleness
- Form : 3 qualities - Change in size, shape and assembly of petals
- Appearance : 5 qualities - Change in the form in terms of wrinkle, shrinkage, wilting, fading and , deformation

These parameters chosen helps in assessing or knowing the overall qualitative characteristics of a flower.

Pre-testing Observation Tool: A 5 point rating scale was initially developed to assess the changes observed in the flowers and pre-testing. As the experts found difficulty in grading the variations on 5 point scale, it was modified to three point scale.

The 3 point scale followed for measuring the variation in qualities are as follows

Very True/No change - 3

Acceptable/Small change - 2

Unacceptable/Total change - 1.

3.7 Collection of data and analysis

Quantitative data pertaining to colour and moisture was obtained and qualitative data regarding the influence of pre-treatments and packaging methods on freeze dried flowers were obtained from three experts. Three experts from the Department of Resource Management in Consumer Sciences, who were familiar with flower characteristics and have good knowledge about the colours, were identified. They were appraised about the research and were asked to evaluate the samples. During evaluation freeze dried samples were compared with real flowers and reference flowers. The data thus obtained were statistically analysed and interpreted

3.8 Statistical analysis and interpretation

A statistical hypothesis test is a method of making decisions using data, whether from a controlled experiment or an observational study (not controlled). In statistics, a result is called statistically significant if it is unlikely to have occurred by chance alone, according to a pre-determined threshold probability, the significance level. Analysis of variance (ANOVA) test basically compares these two variations (between categories and within categories) and if the variation between categories is relatively high compared to the within categories variation, then the ANOVA test will lead us to reject the null hypothesis. In this research, "One Way Analysis of Variance – ANOVA" was used to interpret the qualitative data to know the effect of selected treatments and between treatments on the quality of exotic flowers in floral freeze dryer. The results emerged out of the quantitative and qualitative analysis are interpreted and presented in Chapter 4.

Chapter IV

RESULTS AND DISCUSSIONS

The results emerged out of the study on "Effect of Selected Preservation Treatments on the Quality of Exotic Flowers in Floral Freeze Dryer" was presented in this chapter and the compiled data was presented under the following heads.

4.1 Testing the effect of different types of solvents on Exotic flowers

4.2 Testing and evaluation of treatments on Exotic Flowers

4.3 Effect of selected treatments on freeze dried Exotic flowers

4.4 Evaluating the effect of different packaging methods of freeze dried Exotic Flowers

4.1 Testing the effect of different types of solvents on Exotic flowers

Flowers already have perfect colour, distinctive shape, characteristic texture patterns. Combination of these properties distinguishes one flower from another can sometimes be their shape, sometimes their colour and sometimes distinctive texture pattern. Treatment of flowers with chemicals helps retain colour, shatterproof and soften the flower. The use of preservative solution is considered a common practice for the preservation of flora stem. With the understanding of the importance of dehydrating alcohols, biological or tissue preservatives, environmental fixers, biological fixatives, buffers, mordant's and modifiers in retaining natural qualities of flowers, 14 different solvents were identified. These were tested on selected flowers to study their effect.

4.1.1 Testing the effect of different types of solvents on Anthurium:

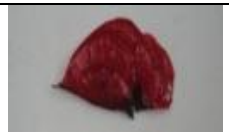
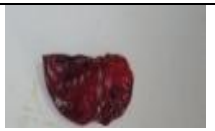
Fresh Anthurium selected for study was a heart-shaped, red Sunset colour flower with the HSB value of H-349, S-68 percent, B-75 percent. The flower had smooth, stiff and leathery texture on the spathe and appeared waxy with fuzzy bumps. Flower had bright yellow green coloured spadix. These characters dominated the appearance of flower.

The effect of 14 chemicals identified in this study, were tested on the spadix to observe the reaction of these on colour, texture and appearance of the flower. The observations recorded are presented in Figure 4.1. It was found that each chemical had an influence on over all physical appearance of the Anthurium.

Tertiary butyl alcohol which is proved to be a harsh dehydrant, turned the red colour spadix into brown and looked pale. 1-propanol was less harsh but turned red colour to darker shade. The petal treated with 2-propanol was more close to natural red but lost its luster and found to be dull, though it has retained the natural texture of the flower. Sodium phosphate turned red to darker shade and shrinkage, wrinkle in spadix was found. Black patch was formed due to accumulation of excess of chemical in the bumps. The petal treated with Sodium formaldehyde Sulphoxylate was more close to natural red and retained shine and leathery texture of the flower. Reaction of Citric acid was also similar to Sodium formaldehyde Sulphoxylate. Treatment with Thiourea caused patches turning the colour darker and also shrinkage was observed. Aluminium sulphate caused spots and the colour has turned darker. These observations coincide with the study conducted by Sierra and John (1982) on red rose.

Sodium citrate which is alkaline has turned the colour darker and a patch was found due to excess of chemical. Treatment with Cupric sulphate the red colour had turned brown and appears to be wilted. Silicone fluid retained red colour and the glossy effect. With Silicone resin formed patches and burns but petal was thick and swollen. Treatment with Phenol, turned red colour into deep red, while Propionic acid has changed red colour to orange shade. A study conducted by Sierra and John (1982) indicated that propionic acid tends to darken a red bloom while phenol tends to lighten a red bloom. A mixture of propionic acid and phenol tends to make the colour more vivid.

From the above observations it can be concluded that citric acid, sodium citrate, Sodium formaldehyde Sulphoxylate, cupric sulphate were suitable to retain colour pigments while t-butyl alcohol, 1-propanol and 2-propanol were found suitable for dehydration. Silicon fluid retained colour and texture while the resin turned the petal fluffy. As all these characteristics are most desired in dried Anthurium, it can be inferred that these chemicals have influence on retaining the colour, texture and appearance of the spathe of Anthurium.

	1	2	3	4	5	6	7
Fresh Flower	**t-butyl alcohol**	**1-propanol**	**2-propanol**	**Sodium phosphate**	**Sodium forlamdeh yde sulphoxylate**	**Citric acid**	**Thiourea**
							
	H- 12,S- 47%,B-54% Hue: Brown (Lotus)	H-347, S-84%, B-65% Hue: Red (Fire Brick)	H-351,S-60%,B-73%, Hue:Red (Blush)	H-353,S-84%,B 392%, Hue: Red (Falu red)	H-350, S-61%, B-68% Hue: Red (Hippie Pink)	H-348,S- 56%,B-72% Hue: Red (Blush)	H-349,S- 52%,B-64% Hue: Red (Cadillac)
	C- Faded	C- Turned darker	C- Faded	C- Turned darker	C- Retained	C- Retained	C- Turned darker and patches found
C: Colour - Hue: Red (Sunset) H-349,S-68%,B-75%	T- very supple	T- soft	T- Pliable	T- Fizzy	T- Very stiff	T- Smooth	T- Fizzy
	A- dry, winkles	A- dry,Wilted	A- dry, lacks lustre	A- Shrinked	A- glossy	A- Shiny	A- Shrinkage
	8	**9**	**10**	**11**	**12**	**13**	**14**
T: Texture - Smooth, stiff and leathery spadix	**Aluminium sulphate**	**Sodium citrate**	**Cupric sulphate**	**Silicone fluid**	**Silicone resin**	**Phenol**	**Propionic acid**
							

A: Appearace - waxy lustre with fuzzy bumps	H-350,S- 56%,B-66% Hue: Red (Hippie Pink)	H-348,S- 48%,B-72%, Hue: Red (Blush)	H- 11,S- 36%,B-44% Hue: Brown (Quincy)	H-356,S- 48%,B-64% Hue: Red (Vin Rouge)	H-350,S-90%,B-63% Hue: Red (Fire Engine Red)	H-348,S- 46%,B-49% Hue: Red (Solid Pink)	H-10, S-70%,B-58% Hue: Orange (Fire)
	C- Turned darker	C- Turned darker	C- Turned darker	C- Retained	C- Turned dark and patches found	C- turned daker	C- Turned darker
	T- Brittle	T- Silky	T- Too soft	T- stiff and smooth	T- smooth	T- Smooth	T- stiff
	A- Wilted and dried	A- Burns found	A- Wilted	A- Fizzy, glossy	A- Swollen and fluffy	A- shrinked and wilted	A- less glossy

Figure 4.1. Testing the effect of solvents on spathe of Anthurium.

4.1.2 Testing the effect of different types of solvents on Bird of Paradise:

Bird of Paradise had pliable, smooth and waxy textured with pointed petals in orange and medium blue colours. Behaviour of 14 chemicals were observed on the bright orange waxy petals on colour, texture and appearance of the flower. The observations recorded are presented in Figure 4.2.

Tertiary butyl alcohol which was proved to be a harsh dehydrant, in Anthurium caused orange colour petal to fade and brown patches were found and looked wilted and dried. 1-propanol also showed same effect as tertiary butyl alcohol but the texture was the texture was pliable and retained sheen. The petal treated with 2-propanol turned darker and lost its lustre, though it has retained the natural texture of the flower. A study conducted by Wei *et al. (*2010) indicated that dehydration feature of alcohols (tertiary butyl alcohol. 1-propanol and 2-propanol) benefits the preserving effect. Sodium phosphate dissolved orange colour causing it to fade and burns were found and appear wilted and the texture became rough.

The petal treated with Sodium formaldehyde Sulphoxylate was more close to natural orange and retained soft texture of the flower but shrinked. Reaction of Citric acid was also similar to Sodium formaldehyde Sulphoxylate but the petal became stiff. The effect of Thiourea also coincides with citric acid and Sodium formaldehyde Sulphoxylate. A study conducted by Wei *et al.* (2010) revealed that the main function of the ingredient, Thiourea, is played as a role to prevent the pigment coming out of the plant. Reaction of Aluminium sulphate and Sodium citrate caused the colour to retain and were soft, supple and pliable. But the petal appeared to be shiny with Aluminium sulphate and the petal wilted when treated with Sodium Citrate.

Treatment with Cupric sulphate caused the orange colour to fade and patches were formed and the petal became rough and stiff and appeared to be wilted and shrinked. Silicone fluid and Silicone resin had similar effects which turned the colour darker and patches were formed and had glossy effect. Treatment with Phenol, orange colour turned darker and burns were found. The petal became stiff and had rough texture and shrinkage was found while Propionic acid has changed the colour darker.

From the above observations it can be concluded that Sodium formaldehyde sulphoxylate, Citric acid, Thiourea, Aluminium sulphate and Sodium citrate were suitable to retain colour pigments while t-butyl alcohol, 1-propanol and 2-propanol were found suitable for dehydration. Silicone fluid and Silicone resin retained the texture.

As all these characteristics are most desired in dried Bird of Paradise, it can be inferred that these chemicals have influence on retaining the colour, texture and appearance of the petals of Bird of Paradise.

	1	2	3	4	5	6	7
Fresh Flower	**t-butyl alcohol**	**1-propanol**	**2-propanol**	**Sodium phosphate**	**Sodium forlamdeh yde sulphoxylate**	**Citric acid**	**Thiourea**
 **C: Colour -** Hue: Orange(Tree Poppy) H-24,S-74%,B-89% **T: Texture -** Smooth, pliable	 H-22,S- 73%,B-69% Hue: Orange (Fiery Orange)	 H-24,S-65%,B-68%, Hue: Orange (Bourbon)	 H-19,S-63%,B-75%, Hue: Orange (Flame Pea)	 H- 17,S- 37%,B-47%, Hue: Brown (Quincy)	 H- 18,S- 74%,B-98% Hue: Orange(Burnt Orange)	 H- 16,S- 71%,B-81% Hue: Orange (Chilean Fire)	 H-23,S-75%,B-100% Hue: Orange (Neon Carrot)
	C- Faded, Brown patches formed	C- Faded, Brown patches formed	C- turned darker, Brown patches formed	C- Faded, burns are found	C- retained	C- retained	C- retained
	T- rough	T- smooth	T- soft, pliable	T- rough	T- soft	T- stiff	T- soft
	A- dried, wilted	A- shrinked	A- lacks lustre	A- wilted	A- shrinked	A- dull, wilted	A- shrinked, wilted
	8	**9**	**10**	**11**	**12**	**13**	**14**
	Aluminium sulphate	**Sodium citrate**	**Cupric sulphate**	**Silicone fluid**	**Silicone resin**	**Phenol**	**Propionic acid**

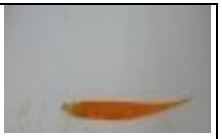
A:Appearace- Waxy and pointed							
	H- 21,S- 75%,B- 99%, Hue: Orange (Burnt Orange)	H-19,S 83%,B-73%, Hue: Brown (chocolate)	H- 18,S- 61%,B- 69% Hue: Orange (Tuscany)	H- 24,S- 67%,B- 75% Hue: Orange(Brandy Punch)	H- 21,S- 62%,B- 64% Hue: Orange (Desert)	H- 18,S- 74%,B- 77% Hue: Orange(Ecstasy)	H- 20,S- 74%,B- 92% Hue: Orange (Pizazz)
	C- retained	C- retained	C- faded, patches formed	C- turned darker, patches formed	C-- turned darker, patches formed	C- turned darker, burns found	C- turned darker,
	T- soft, supple	T- pliable	T- rough, stiff	T- glossy	T- glossy	T- rough, stiff	T- soft, pliable
	A- shiny	A- wilted	A- wilted, shrinked	A- wilted, shrinked	A- shrinked	A- shrinkage	A- shiny

Figure 4.2. Testing the effect of solvents on petals of Bird of Paradise.

4.1.3 Testing the behaviour of different types of solvents on Asiatic Lily:

Fresh Asiatic Lily selected for study was a starry, trumpet shaped flower in orange colour with the HSB value of H-11, S-73 percent, B-84 percent. The flower had thick but pliable petal which was succulent and soft. These characters were prominent in the appearance of flower.

The effect of 14 chemicals identified in this study, were tested on the petals to observe the reaction of these on colour, texture and appearance of the flower. The observations recorded are presented in Figure 4.3. It was found that each chemical had an influence on over all physical appearance of Asiatic Lily.

Bright orange petal of Asiatic Lily appeared faded and lusterless with t- butyl alcohol as observed in Anthurium and Bird of Paradise. Its reaction with 1-propanol and 2-propanol were less harsh by dissolving the colour but were soft and pliable, retaining the natural texture of the flower.

Sodium phosphate turned orange to darker shade and burns were found. The texture was coarse and appeared to be wilted. The petal treated with Sodium formaldehyde Sulphoxylate was more close to natural in retaining the supple texture but faded and appeared wilted. Treatment with Citric acid retained the colour and smooth texture but found to be dull. Thiourea caused fading of colour but was soft. Reaction of Aluminium Sulphate was also similar to Citric acid. These observations coincide with the study conducted by Sierra and John (1982) on red rose.

Sodium citrate which is alkaline has retained the colour and texture of natural flower but shriveling was seen. Treatment with Cupric sulphate retained the texture and appearance of natural flower but colour has faded. Silicone fluid caused the colour to fade and shrinked but had a glossy effect. With Silicone resin colour was retained and had glossy and fluffy effect. Treatment with Phenol, turned darker and luster was lost, while Propionic acid has changed orange colour to pinkish tinge and appeared wilted and shrinked. A study conducted by Wei *et al.* (2010) reveals that the preserving effect will be influenced by the concentration of acidic ingredients in preserving solution.

From the above observations it can be concluded that Citric acid, Aluminium sulphate, Sodium citrate and Silicone resin were suitable to retain colour pigments while t-butyl alcohol, 1-propanol and 2-propanol were found suitable for dehydration. As all these characteristics are most desired in dried Asiatic Lily, it can be inferred that these chemicals have influence on retaining the colour, texture and appearance of the petals of Asiatic Lily.

	1	2	3	4	5	6	7
Fresh Flower	**t-butyl alcohol**	**1-propanol**	**2-propanol**	**Sodium phosphate**	**Sodium forlamdeh yde sulphoxylate**	**Citric acid**	**Thiourea**
 **C: Colour-** Hue: Orange(Chilean Fire) H -11 S- 73% B- 84% **T: Texture -** Thick but pliable petal succulent and soft							
	H- 33,S- 60%,B- 85% Hue: Orange (Porsche)	H- 27,S- 62%,B- 89% Hue: Orange(Porsche)	H-31,S- 60%,B- 86%, Hue: Orange (Porsche)	H-16,S-63%,B- 70%, Hue: Orange(Tuscany)	H-24,S-64%,B- 88% Hue: Orange (Jaffa)	H-23,S-59%,B- 96% Hue: Brown (Sandy Brown)	H-22,S- 57%,B- 98% Hue:Orange (Hit Pink)
	C-faded	C- faded	C- faded	C- turned darker, burns found	C- faded	C- retained	C- faded
	T- coarse	T- soft	T- pliable	T- coarse	T- supple	T- smooth	T- soft
	A- lacks lustre	A- dull	A- shrinked	A- wilted	A- wilted	A- dull	A- lacks lustre
	8	**9**	**10**	**11**	**12**	**13**	**14**
	Aluminium sulphate	**Sodium citrate**	**Cupric sulphate**	**Silicone fluid**	**Silicone resin**	**Phenol**	**Propionic acid**

A:Appearace- starry, trumpet shaped flowers							
	H-22,S- 63%,B-98% Hue: Brown (Sandy Brown)	H-24,S-66%,B-100% Hue: Orange (Atomic Tangerine)	H-26,S- 63%,B-98% Hue: Orange (Rajah)	H-29S- 71%,B-98% Hue:Orange(Sunshade)	H-34,S-82%,B-85% Hue: Yellow (Buttercup)	H-19,S-64%,B-90% Hue: Orange (Jaffa)	H-24,S-67%,B-95%, Hue:Orange (Crusta)
	C-retained	C- retained	C- faded	C- faded	C- retained	C- turned darker	C- pinkish tinge
	T- smooth	T- smooth	T- supple	T- glossy	T- glossy	T- rough	T- supple
	A- lacks lustre.	A- Shriveling is seen	A- silky	A- shrinked.	A- fluffy	A- lacks lustre	A- Wilted, shrinked

Figure 4.3. Testing the effect of solvents on petals of Asiatic Lily.

4.1.4 Testing the behaviour of different types of solvents on Orchids:

Fresh Orchid selected for study was a flat-faced petals and sepals of equal size Violet (Persian Indigo) flower with the HSB value of H-298, S-84 percent and B-53 percent. The flower had stiff, velvety and glossy petals. The effect of 14 chemicals identified in this study, were tested on the flower to observe the reaction of these on colour, texture and appearance of the flower. The observations recorded are presented in Figure 4.4. It was found that each chemical had an influence on over all physical appearance of the Orchid.

As Tertiary butyl alcohol is a harsh dehydrant it caused the flower to fade and dissolved the colour. The texture of the natural flower is thick but it became supple and shriveled with this treatment. 1-propanol was less harsh but turned violet colour to darker shade and patches were formed. The petal treated with 2-propanol was more close to natural violet but lost its lustre and found to be dull, though it has retained the natural texture of the flower.

Sodium phosphate and Sodium formaldehyde Sulphoxylate had similar effect which faded and dissolved the colour causing change in hue and became coarse and wilted. Reaction of Citric acid helped in retaining the colour but was too supple and lacked firmness. Treatment with Thiourea retained the natural hue but the texture became coarse and luster was lost. Aluminium sulphate caused to retain the colour, texture and appearance of natural flower. The flower was soft and shiny.

Sodium citrate which is alkaline has turned the colour darker but was smooth and wilting was found. Treatment with Cupric sulphate had turned the violet colour to darker shade. The texture was soft and shrinkage was observed. Silicone fluid turned the colour darker and shriveled but had glossy effect. With Silicone resin colour was retained and had glossy effect. Treatment with Phenol, changed the hue, became brittle and dried while Propionic acid has changed the colour to darker shade and appeared dull.

From the above observations it can be concluded that 2-propanol, Aluminium sulphate and Citric acid were suitable to retain colour pigments while t-butyl alcohol, 1-propanol and Sodium phosphate were found suitable for dehydration. Silicon fluid and Silicone resin retained the glossy effect. As all these characteristics are most desired in

dried Orchid, it can be inferred that these chemicals have influence on retaining the colour, texture and appearance of the petals of Orchid.

Research conducted by Lee (2000) on preservation of flowers, the findings revealed that the solution will normally contain other additives depending on the flower species and particularly orchid species to be preserved. Among such additives are, thiourea, cysteine hydrochloride, peracetic acid or polyvinyl alcohol in various combinations.

	1	2	3	4	5	6	7
Fresh Flower	**t-butyl alcohol**	**1-propanol**	**2-propanol**	**Sodium phosphate**	**Sodium forlamdeh yde sulphoxylate**	**Citric acid**	**Thiourea**
							
C: Colour - Hue: H -298, S- 84% , B -53% Violet(Persian Indigo) **T: Texture** – Stiff, velvety and glossy petal **A:Appearace-** Flat-faced petals	H-302,S-100%,B-45% Hue: Violet (Purple)	H-298,S-100%,B-59% Hue: Violet (Dark Violet)	H-298,S- 98%,B-39%, Hue: Violet (Indigo)	H-302,S- 99%,B-55%, Hue: Violet (Dark Magenta)	H-354,S-40%,B-76% Hue: Red (Contessa)	H-296,S-100%,B-52% Hue: Violet (Indigo)	H-297,S-75%,B-55% Hue: Violet (Vivid Violet)
	C- faded and dissolved	C- turned darker, patches formed	C- retained	C- faded and dissolved	C- faded	C- retained	C- retained
	T- supple	T- pliable	T- soft	T- coarse	T- rough	T- supple	T- coarse
	A- shrivelled	A- lacks lustre	A- dull	A- wilted	A- dried	A- lacks firmness	A- lacks lustre
	8	**9**	**10**	**11**	**12**	**13**	**14**
	Aluminium sulphate	**Sodium citrate**	**Cupric sulphate**	**Silicone fluid**	**Silicone resin**	**Phenol**	**Propionic acid**

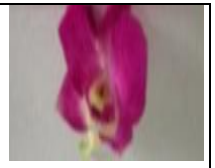
							
	H-298,S-100%,B-44% Hue: Violet (Indigo)	H-296,S- 97%,B-54%, Hue: Violet (Indigo)	H-300,S-100%,B-53% Hue: Violet (Dark Magenta)	H-18,S-34%,B-80% Hue: Brown(Cameo)	H- 21,S-35%,B- 70% Hue: Red (Brandy Rose)	H-321,S-57%,B-47% Hue: Red (Flirt)	H-340,S-65%,B- 82% Hue: Red (Cabaret)
	C- retained	C- turned darker	C-turned darker	C- turned darker	C- retained	C- turned darker	C- turned darker
	T- soft and supple	T- smooth	T- soft	T- glossy	T- glossy	T- brittle	T- soft
	A- shiny	A- wilted	A- shrinked	A- shrivelled	A- wilted	A- dried	A- dull

Figure 4.4. Testing the effect of solvents on Orchid.

4.1.5 Testing the behaviour of different types of solvents on Statice :

The fresh Statice flower selected for study was a cluster of calyxes with small flowers which was thick but pliable on the inside and had stiff angular stems in Violet (Mountain's Majesty) colour with the HSB value of H- 281, S- 34 percent; B -74 percent. The flower had soft texture.

The effect of 14 chemicals identified in this study, were tested on the flower to observe the reaction of these on colour, texture and appearance of the flower. The observations recorded are presented in Plate 4.5. Tertiary butyl alcohol has proved to be a harsh dehydrant, causing the flower to turn brittle and turned the violet colour to a darker shade and also luster was lost. 1-propanol was less harsh but turned violet colour to darker shade and petals were pliable and fizzy. In Orchid, when treated with 2-propanol retained colour, similarly in Statice , colour was retained and was more close to natural violet but became coarse and appeared dull.

Sodium phosphate turned violet colour to darker shade and was found pliable and appeared fizzy. The petal treated with Sodium formaldehyde Sulphoxylate was faded and the texture became coarse and wilted. Reaction of Citric acid on statice had pinkish tinge and texture of the flower became rough and found wilted. Treatment with Thiourea caused fading of colour and became brittle and wilted. Aluminium sulphate had retained the colour but became brittle and luster was lost. A study conducted by Nowack and Rudnicki (1990) said that visual observations during the period of experimentation revealed that the cut roses held in aluminium sulphate retained a desirable freshness of the bloom.

Sodium citrate which is alkaline has proved to be good for this flower as it has retained the natural colour and it was soft, pliable and luscious. With Cupric Sulphate caused the colour to fade and shrinkage and brittle was found. Silicone fluid and Silicone Resin exhibited fading of the colour and wilted but had glossy effect. Treatment with Phenol, had pinkish tinge became coarse and found to be dull, while Propionic acid has turned darker, brittle and wilted.

From the above observations it can be concluded that Aluminium sulphate and Sodium citrate was suitable to retain colour pigments while t-butyl alcohol, 1-propanol and 2-propanol were found suitable for dehydration. As all these characteristics are most desired in dried Statice, it can be inferred that these chemicals have influence on retaining the colour, texture and appearance of the Statice.

	1	2	3	4	5	6	7
Fresh flower	**t-butyl alcohol**	**1-propanol**	**2-propanol**	**Sodium phosphate**	**Sodium forlamdeh** **yde sulphoxylate**	**Citric acid**	**Thiourea**
							
C: Colour - Hue: H- 281, S- 34%, B -74% Violet(Mountain's Majesty) **T: Texture** –soft	H-285,S- 37%,B-56% Hue: Violet (Affair)	H- 286,S- 45%,B-49%, Hue: Violet(Affair)	H-290,S-50%,B-56%, Hue: Violet (Affair)	H-279,S-46%,B- 51%, Hue: Violet (Affair)	H- 286,S-49%,B-59% Hue: Violet (Studio)	H- 289,S-44%,B-60% Hue: Violet (Affair)	H- 285,S-46%,B-56% Hue: Affair (Violet)
	C- turned darker	C- turned darker	C- retained	C- turned darker	C- faded	C-Turned to pink	C- faded
	T- brittle	T- Pliable	T- coarse	T- pliable	T- coarse	T- rough	T- brittle
	A-lacks lustre	A- Fizzy	A- dull	A- Fizzy	A- wilting	A- wilting	A- wilted
	8	**9**	**10**	**11**	**12**	**13**	**14**
A:Appearace-	**Aluminium sulphate**	**Sodium citrate**	**Cupric sulphate**	**Silicone fluid**	**Silicone resin**	**Phenol**	**Propionic acid**

Clustered petals							
	H-287,S-37%,B-60% Hue: Violet (Ce Soir)	H-278,S-51%,B-51%, Hue: Violet (Eminence)	H-284,S-42%,B-47% Hue: Violet (Honey Flower)	H-297,S-34%,B-52% Hue: Violet(Affair)	H-279,S-19%,B- 46% Hue:Violet (Rum)	H-305,S-34%,B-57% Hue: Violet (Violet Blue)	H-286,S-42%,B-58%, Hue: Violet(Affair)
	C- retained	C- retained	C- faded	C- faded	C- faded	C- Turned to pink	C- turned darker
	T- brittle	T- Soft and pliable.	T- brittle	T- glossy	T- glossy	T- coarse	T- brittle
	A- lacks lustre	A- luscious	A- shrinkage	A- wilting	A- wilting	A- dull	A- wilting

Figure 4.5. Testing the effect of solvents on Statice.

Results revealed that each of the chemical tested on each flower reacted differently on colour, texture and appearance of flower petals. Tertiary butyl alcohol, 1 - Propanol, and 2 - Propanol were found to open cell structure and dissolved colour pigments and dehydrate petals. Citric acid, Sodium Citrate, Cupric sulphate, Aluminium Sulphate, and Sodium Formaldehyde Sulfoxylate, Thiourea, Phenol, Propionic acid retained colour pigments while silicone resin and silicone fluid formed glossy shied on the surface.

The study also revealed that Citric acid, Sodium citrate, Sodium formaldehyde Sulphoxylate, Cupric sulphate was suitable to retain red colour pigments of Anthurium while t-butyl alcohol, 1-propanol and 2-propanol were found suitable for dehydration. Silicon fluid retained colour and texture while the resin turned the petal fluffy. For petals of Bird of Paradise, Sodium Formaldehyde Sulphoxylate, Citric acid, Thiourea, Aluminium sulphate and Sodium citrate were suitable to retain the orange colour pigments. For Asiatic Lily, Citric acid, Aluminium sulphate, Sodium citrate and Silicone resin were suitable to retain the orange colour pigments. For Orchid flower, 2-propanol, Aluminium sulphate and Citric acid were suitable to retain violet colour pigments. Violet colour in Statice flower was retained by Aluminium sulphate and Sodium citrate. For all the petals and flowers t-butyl alcohol, 1-propanol and 2-propanol were found suitable for dehydration and Silicon fluid and Silicone resin retained the glossy effect.

In observations made through above analysis have reconfirmed the views of Sierra and John (1982), on the role of chemical treatments on flowers. From this analysis, it can be concluded that, a blend of each of these characteristics of different chemicals is necessary to retain the inherent qualities of flowers. Hence, the blends reported in methodology were tested, to study effect of each of the blends on exotic flowers.

4.2 Testing and Evaluation of Treatments on Exotic Flowers

Different parameters *viz*., colour variables, moisture loss and physical observation score of colour, texture, form and appearance were recorded for determination of suitability of five different treatments for freeze-dried flowers. Experiment I was carried out with basic compositions and Experiment II was carried out with improved compositions with inclusion of Shatter resistant polymer. The results emerged out of the experiments on selected flowers are presented below.

4.2.1 Effect of treatments on Anthurium :

Bright red colour Anthurium was tested to explore the suitability of different compositions. The picture of fresh Anthuium, Anthurium freeze dried without any treatment, effect of treatments on experiment I and II on freeze dried Anthurium, the colour variables measured in terms of Hue (H), Saturation (S) and Brightness (B), the name of hue and colour based on HSB values and moisture loss in different treatments are shown in Figure 4.6. Illustrations presented in this Table for Anthurium flower with and without treatments, showed the marked variation in terms of colour, form, shape and texture. Freeze dried Anthurium without any treatment resulted in colour loss, over dried and brittle textured, without gloss and sheen, though it retained form. This highlights the importance of pre-treatment for retaining the inherent qualities of flower.

Experiment I with basic compositions showed the variation in colour, form, shape and texture. Flowers treated with composition-II, IV and V retained red hue while the other two compositions changed the hue to brown. It was also observed that irrespective of composition, all the flowers appeared dull, dry and brittle. This proves that chemical used in different composition had influence on the quality of flowers. Anthurium treated with shatter resistant polymer in Experiment II, resulted in having all flowers in red hue, and looked brighter than the above observation. Even among these, composition V retained all the qualities of flowers close to reference flower, except for change in texture. Though Composition III and IV retained colour, flowers were found to be dried due to which wrinkles and shrinkage is observed (Figure 4.6).

In all the treatments the moisture loss percentage varied between 85%-93% in all the flowers and it remained consistent between experiments. Basic compositions resulted in excessive dryness in comparison to improved compositions.

From the above analysis it can noted that colour and moisture content were influence by the choice of chemicals in both the treatments. The improved composition V was found to produce more natural looking flower. Though composition IV was more close to V, the inherent gloss desired in Anthurium was lacking.

Table 4.1. Physical Observation score of Freeze Dried Anthurium

Physical Observation Score	Comp-I		Comp-II		Comp-III		Comp-IV		Comp-V	
	BC	**IC**	BC	**IC**	BC	**IC**	BC	**IC**	BC	**IC**
Colour	13	**18**	13	**15**	13	**12**	17	**25**	20	**27**
Texture	14	**20**	14	**22**	14	**21**	14	**21**	17	**23**
Form	19	**27**	18	**25**	18	**26**	18	**27**	21	**27**
Appearance	20	**42**	21	**40**	21	**39**	23	**44**	30	**41**
Total	66	**107**	66	**103**	66	**98**	72	**117**	88	**118**

Table 4.2. ANOVA - One way Classification Table for Anthurium

ANOVA **Within Experiment-I**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	225	3	75	9.9337*	0.00061	3.238872
Within Groups	120.8	16	7.55			
Total	345.8	19				

ANOVA **Within Experiment-II**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1455.4	3	485.1333	41.20028*	9.420	3.238872
Within Groups	188.4	16	11.775			
Total	1643.8	19				

ANOVA **Between Experiment-I & Experiment-II**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1394.6	3	464.8667	11.61038*	0.00001	2.8662
Within Groups	1441.4	36	40.03889			
Total	2836	39				

* - Significant difference at 5 percent level

These scores were statistically analysed to establish the influence of treatments on overall quality of flowers. Table 4.2. (Anova one-way classification table) on Anthurium revealed that there was significant difference in the quality of flowers within treatments and between treatments. The Mean sum of squares is largest for within Experiment II between groups coinciding with the physical observations made and its least for within Experiment I between groups. The Mean sum of squares is second largest for between Experiment I and Experiment II, between groups It was hypothesized that pre-treatment has no significant difference on the overall quality of freeze-dried exotic flowers so the null hypothesis is rejected. Since calculated value of F is greater than the table value of F, null hypothesis is rejected. From this analysis, it can be drawn that the choice of chemicals influenced the quality of freeze dried Anthurium

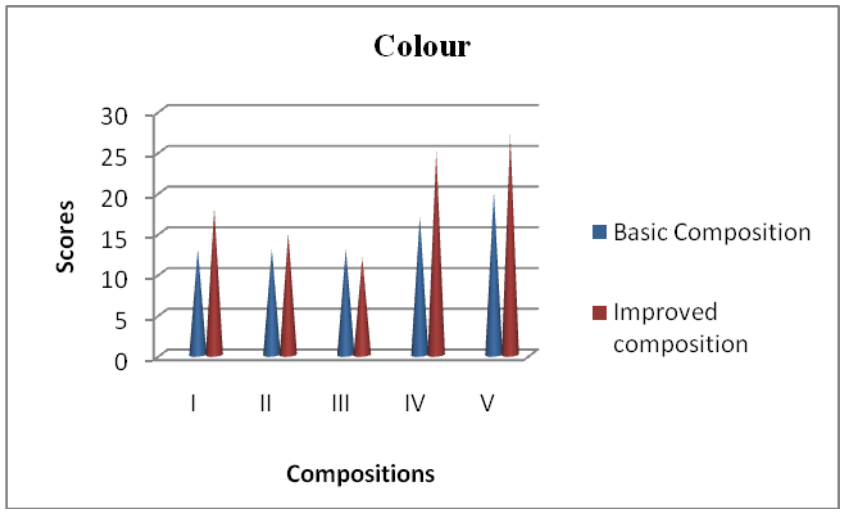
Experts panel scores (Table 4.1) on qualitative parameters of Anthurium treated and freeze dried with basic five compositions (BC), revealed that scores for the colour, Texture, form and appearance was found to have lesser score than improved composition (IC) Among the five basic and improved compositions, Composition IV and V received the maximum score points for colour, form and appearance. However texture scored least score irrespective of the treatment as the flowers were hard and dry.

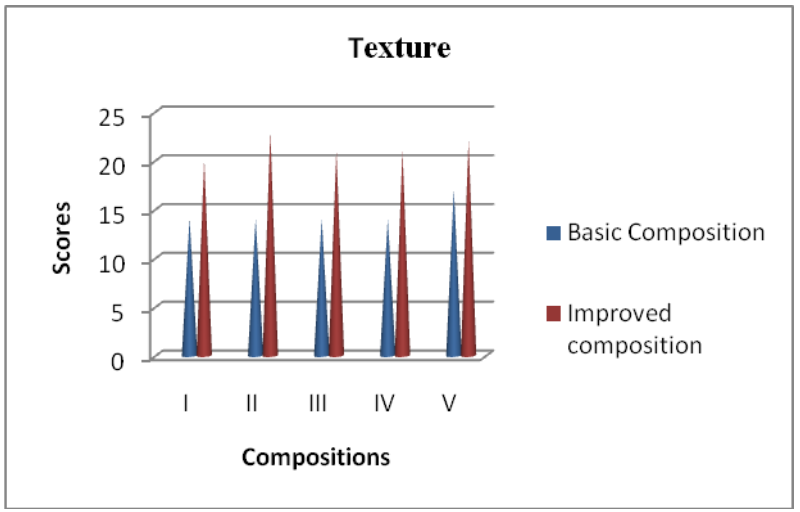
Results emerged out of the analysis coincides with the research reported by Sierra and John (1982) where silicone treatment emerges with better quality of flower. It was reported that neither the silicone fluid or resin play any part in the colour preservation of the flowers but they do affect the physical and biological properties involved in the resistance of the flowers to withstand mechanical and environmental stresses, essentially rough handling, humidity and temperature. Use of silicon resin and fluid in composition V resulted in flowers with less resistance to breakage and retains the brightness of the natural flower. A study conducted by Chen *et al.* (2000) indicated that freeze drying had a greater effect on the colour values of the red flowers and the reds often become unattractively dark and muddy.

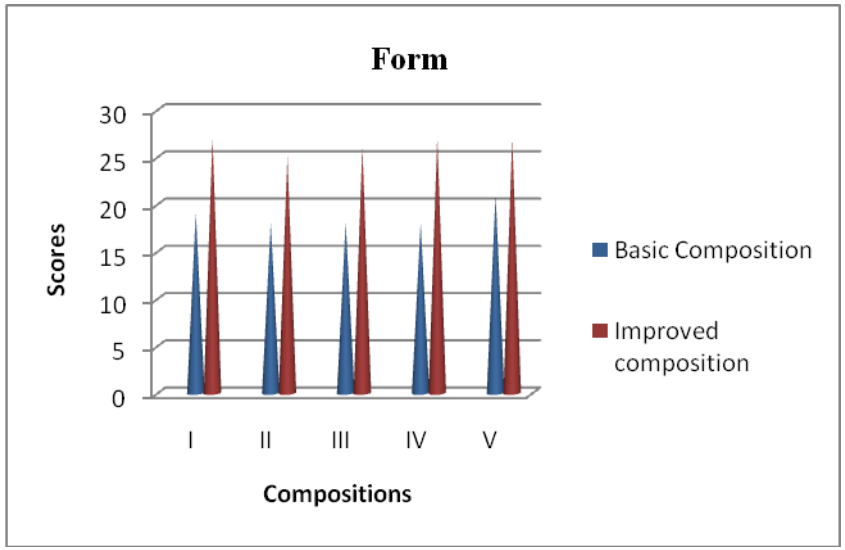
Reference		Treatment of Anthurium Flower with Different Compositions				
							
Fresh flower		**Experiment -1**	Composition-I	Composition-II	Composition-III	Composition-IV	Composition-V
H 349 S 68% B 75%			H 356 S 33% B 34%	H 354 S 46% B 27%	H 354 S 52% B 24%	H 346 S 63% B 33%	H 346 S 56% B 36%
Red(Sunet)			Brown(Van Cleef)	Red(Red wood)	Brown (Cocoa)	Red (Bordeaux)	Red (Jazz)
			B-6 A-0.8 M-87%	B-6.4 A-0.8 M-87%	B-7.4 A-1 M-86%	B-6.4 A-0.8 M-87%	B-8.2 A-1 M-88%
							
Freeze Dried		**Experiment -2 Improved compositions with shatter resistant Polymer**	Composition-I	Composition-II	Composition-III	Composition-IV	Composition-V
H 357 S 74% B 64%			H 344 S 53% B 40%	H 345 S 72% B 36%	H 342 S 68% B 35%	H 344 S 75% B 58%	H 343 S 59% B 53%

Brown			Red(Persian Plum)	Red(Pohutukawa)	Red (Red Oxide)	Red (Bright Red)	Red (Camelot)
			B-6.4 A-0.4 M-94%	B-9.2 A-1 M-89%	B-6 A-0.4 M-93%	B-6.8 A-1 M-85%	B-5.6 A-0.8 M-86%

Figure 4.6. Effect of treatments on Anthurium.







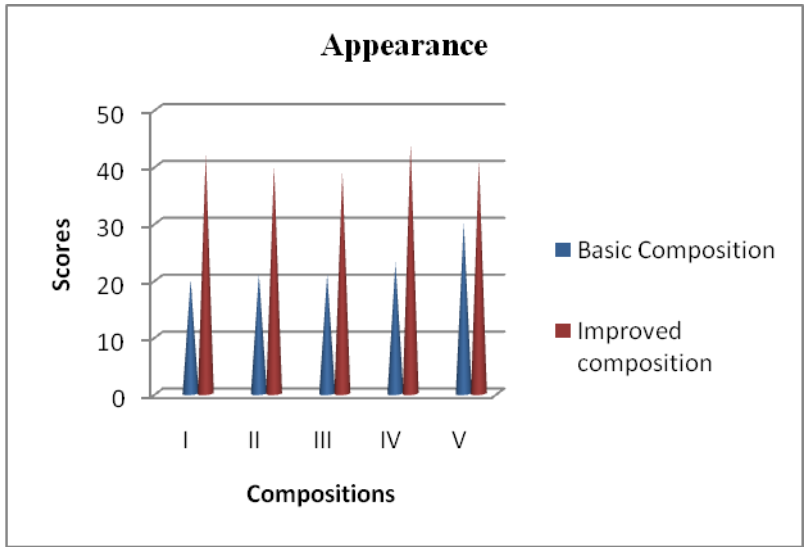


Figure 4.7. Score values for colour, texture, form and appearance of Anthurium.

4.2.2 Effect of treatments on Bird of Paradise :

Bird of Paradise was tested with all the basic and improved compositions to explore the suitability of these on freeze dried state. The images in Figure 4.8. shows the picture of fresh Bird of Paradise, Bird of Paradise freeze dried without any treatment, effect of treatments on experiment I and II on freeze dried Bird of Paradise, the colour variations measured in terms of Hue (H), Saturation (S) and Brightness (B), the name of hue and colour based on HSB values and moisture loss in different treatments. Keen observation of flowers with and without treatments, showed a marked variation in terms of colour, form, shape and texture. Freeze dried Bird of Paradise without any treatment resulted in colour loss, over dried and brittle, without any gloss and sheen, though it retained form. This observation highlights the importance of pre-treatment for retaining the inherent qualities of flower.

Experiment I with basic compositions showed the variation in colour, form, shape and texture. Flower treated with composition-III retained orange hue while the compositions I and II changed the hue to red. It was also observed that irrespective of composition, all the flowers appeared dark, dull, dry and brittle. Flowers in this experiment did not retain the green colour bract of the flower as patches were found on it. This may be due to the imbalance in pH or due to the accumulation of excess of chemical. A study conducted by Sierra (1988) reveals that pH control of the formulation is necessary for consistent results and preferably the pH should be in the range 6.0-6.5. If no green is present in the bloom to be treated the pH may be as low as 5 and pH 7 is preferred for the treatment of green. This proves that chemical used in different composition had influence on the quality of flowers.

Bird of Paradise treated with shatter resistant polymer in Experiment II, resulted in having all flowers in orange hue, except composition-V and looked brighter than the above observation. Even among these, composition I retained all the qualities of flowers close to reference flower, except for change in texture. Though Composition II, III and IV retained colour, flowers were found to be dried due to which wrinkles and shrinkage is observed.

In all the treatments the moisture loss percentage varied between 82%-92% in all the flowers and it did not remain consistent between experiments. Basic compositions resulted in excessive dryness in comparison to improved compositions.

Table 4.3. Physical Observation score of Freeze Dried Bird Of Paradise

Physical Observat-ion Score	Comp-I		Comp-II		Comp-III		Comp-IV		Comp-V	
	BC	IC	BC	IC	BC	IC	BC	IC	BC	IC
Colour	15	**18**	15	**13**	16	**17**	15	**24**	16	**15**
Texture	15	**14**	12	**11**	11	**15**	12	**21**	11	**13**
Form	15	**27**	15	**15**	12	**21**	20	**19**	12	**20**
Appearance	23	**24**	22	**26**	20	**32**	25	**36**	19	**25**
Total	68	**83**	64	**65**	59	**85**	72	**100**	58	**73**

Table 4.4. ANOVA - One way Classification Table for Bird Of paradise

ANOVA **Within Experiment-I**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	209.75	3	69.91667	11.276*	0.000319	3.238872
Within Groups	99.2	16	6.2			
Total	308.95	19				

ANOVA **Within Experiment-II**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	537.8	3	179.2667	9.3004*	0.000854	3.238872
Within Groups	308.4	16	19.275			
Total	846.2	19				

ANOVA **Between Experiment-I & Experiment-II**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	687.875	3	229.297	11.750*	0.000016	2.86626
Within Groups	702.5	36	19.5138			
Total	1390.375	39				

* - Significant difference at 5 percent level

These scores were statistically analysed to establish the influence of treatments on overall quality of flowers. Table 4.4. (Anova one-way classification table) on Bird Of paradise revealed that there was significant difference in the quality of flowers within treatments and between treatments. The Mean sum of squares is largest for within Experiment-II between groups coinciding with the physical observations made

and its least for within Experiment-I between groups. The Mean sum of squares is second largest for between Experiment -I and Experiment-II, between groups It was hypothesized that pre-treatment has no significant difference on the overall quality of freeze-dried exotic flowers so the null hypothesis is rejected. Since calculated value of F is greater than the table value of F, null hypothesis is rejected. From this analysis, it can be drawn that the choice of chemicals influenced the quality of freeze dried Bird of Paradise.

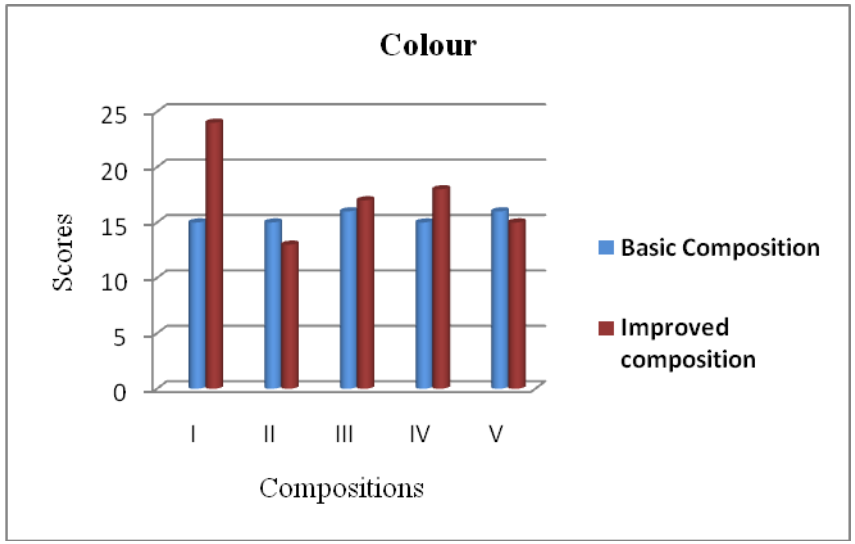
Expert's panel scores(Table 4.3) on qualitative parameters of Bird of Paradise treated and freeze dried with basic five compositions (BC), revealed that scores for the colour, Texture, form and appearance was found to have lesser score than improved composition. Among the five basic and improved compositions, Composition-I (IC) received the maximum score points for colour, texture and appearance. However texture scored least score irrespective of the treatment as the flowers were hard and dry.

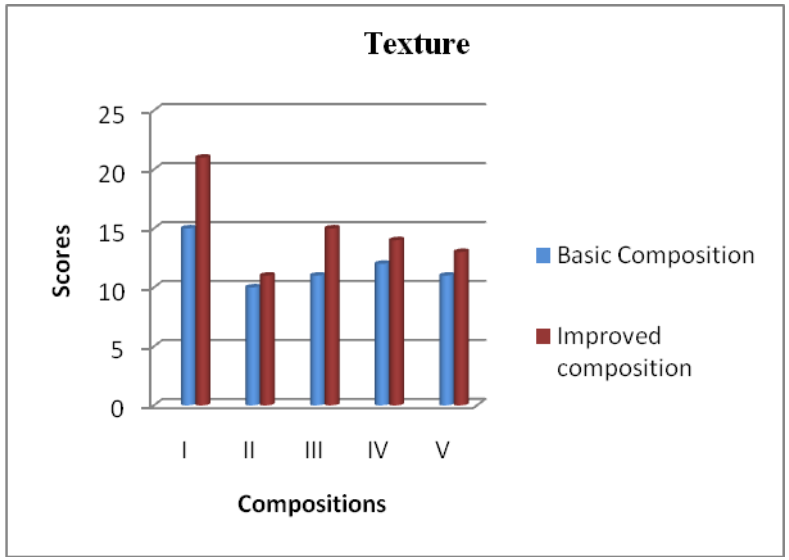
From the above analysis it can be noted that colour and moisture content were influence by the choice of chemicals in both the treatments. The improved composition IV was found to produce more natural looking flower. This coincides with the research done by Jain (2011) who stated that EVA Emulsion offers good adhesive strength and good thickening response. Though composition I little closer to composition IV, the natural green colour of the stem desired in Bird of Paradise was lacking.

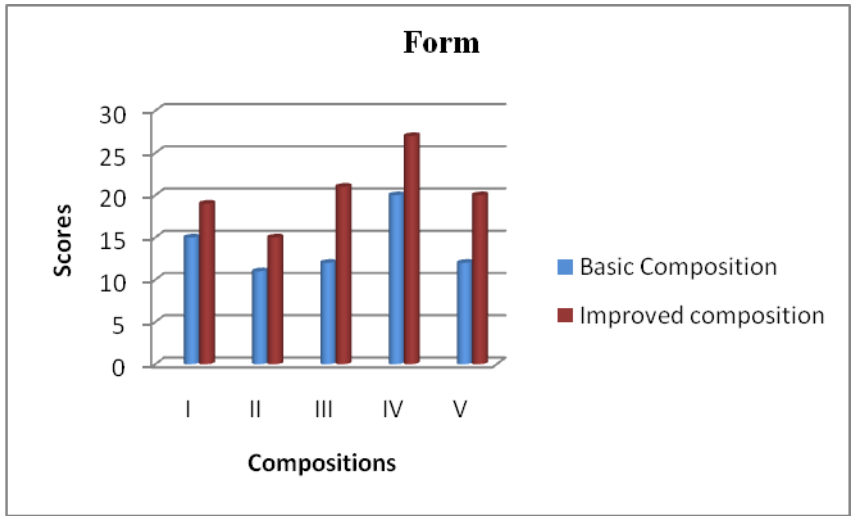
Reference Flower		Treatment of Bird Of Paradise Flower with Different Compositions					
		**Experiment -1 Basic compositions**					
Fresh flower			Composition-I	Composition-II	Composition-III	Composition-IV	Composition-V
H-24 S-74% B- 89%			H 18 S 90% B 65%	H 21 S 99% B 58%	H 25 S 100% B 71%	H 21 S 86% B 67%	H 29 S 98% B 56%
Orange(Tree Poppy)			Red(Rust)	Red(Dark Red)	Orange(Tawny)	Brown(Golden Brown)	Green(Olive)
			B- 22.8 A-3.6 M-84%	B-32.6 A-4 M-88%	B-39.6 A-3.2 M- 92%	B-59.6 A-6.8 M-88%	B-45 A-3.2 M-93%
		**Experiment-2 Improved compositions with**					

Freeze Dried			Composition-I	Composition-II	Composition-III	Composition-IV	Composition-V
H-33, S-68% ,B- 83%			H 29 S 95% B 76%	H 23 S 82% B 72%	H 27 S 80% B 66%	H 21 S 76% B 73%	H 19 S 89% B 64%
Brown(Peru)			Orange(Tawny)	Orange(Christine)	Orange(Rich gold)	Orange(Christine)	Red(Rust)
			B-42 A-5 M-88%	B-68.2 A-8.2 M-88%	B-40.6 A-5.2 M-87%	B-44.8 A-7 M-84%	B-26.4 A-3.4 M-87%

Figure 4.8. Effect of treatments on Bird Of Paradise.







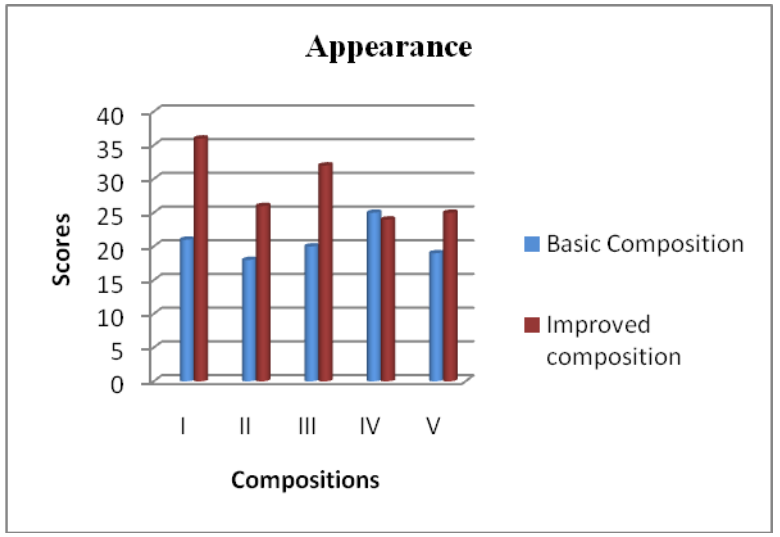


Figure 4.9. Score values for colour, texture, form and appearance of Bird of Paradise.

4.2.3 Effect of treatments on Asiatic Lily:

Bright orange colour Asiatic Lily was tested to explore the suitability of different compositions. The picture of fresh Asiatic Lily, Asiatic Lily freeze dried without any treatment, effect of treatments on experiment I and II on freeze dried Asiatic Lily, the colour variables measured in terms of Hue (H), Saturation (S) and Brightness (B), the name of hue and colour based on HSB values and moisture loss in different treatments are shown in Figure 4.10. Illustrations presented in this plate for Asiatic Lily flower with and without treatments, showed the marked variation in terms of colour, form, shape and texture. Freeze dried Asiatic Lily without any treatment resulted in form distortion, over dried and brittle textured, without gloss and sheen, and mildly faded. This highlights the importance of pre-treatment for retaining the inherent qualities of flower.

Experiment I with basic compositions showed the variation in colour, form, shape and texture. Flowers treated with composition-II retained orange hue while the compositions I, IV and V changed the hue to red. It was also observed that irrespective of composition, all the flowers appeared dry and brittle. This proves the need for improving the chemical composition of treatments.

Asiatic Lily treated with shatter resistant polymer in Experiment II, resulted in having all flowers in orange hue, except composition-III and looked brighter than the above observation. Even among these, composition IV and V retained all the qualities of flowers close to reference flower, except for change in texture. Though Composition III appear close to natural colour, flower was found to be dried due to which wrinkles and shrinkage is observed.

In all the treatments the moisture loss percentage varied between 87%-94% in all the flowers and it did not remain consistent between experiments. Basic compositions resulted in excessive dryness in comparison to improved compositions.

From the above analysis it can noted that colour and moisture content were influence by the choice of chemicals in both the treatments. The improved composition IV and V were found to produce more natural looking flowers. Though composition I and II was more close to IV and V, the inherent gloss desired in Asiatic Lily was lacking.

Table 4.5. Physical Observation score of Freeze Dried Asiatic Lily

Physical Observation Score	Comp-I		Comp-II		Comp-III		Comp-IV		Comp-V	
	BC	IC	BC	IC	BC	IC	BC	IC	BC	IC
Colour	18	**20**	24	**22**	15	**19**	16	**22**	23	**25**
Texture	17	**17**	12	**15**	17	**18**	11	**24**	9	**17**
Form	18	**14**	9	**16**	18	**12**	9	**24**	24	**22**
Appearance	32	**31**	21	**31**	29	**28**	21	**39**	35	**29**
Total	85	**82**	66	**84**	79	**77**	87	**109**	91	**93**

Table 4.6. ANOVA - One way Classification Table for Bird Of paradise

ANOVA **Within Experiment-I**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	595.8	3	198.6	7.0300*	0.003142	3.238872
Within Groups	452	16	28.25			
Total	1047.8	19				

ANOVA **Within Experiment-II**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	629.35	3	209.7833	13.404*	0.000124	3.238872
Within Groups	250.4	16	15.65			
Total	879.75	19				

ANOVA **Between Experiment-I & Experiment-II**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1210.47	3	403.491666	17.515*	3.52879	2.86626
Within Groups	829.3	36	23.0361111			
Total	2039.775	39				

* - Significant difference at 5 percent level

These scores were statistically analysed to establish the influence of treatments on overall quality of flowers. Table 4.6. (Anova one-way classification table) on Asiatic Lily revealed that there was significant difference in the quality of flowers within treatments and between treatments. The Mean sum of squares is largest for within

Experiment-II between groups coinciding with the physical observations made and its least for within Experiment-I between groups. The Mean sum of squares is second largest for between Experiment -I and Experiment-II, between groups It was hypothesized that pre-treatment has no significant difference on the overall quality of freeze-dried exotic flowers so the null hypothesis is rejected. Since calculated value of F is greater than the table value of F, null hypothesis is rejected. From this analysis, it can be drawn that the choice of chemicals influenced the quality of freeze dried Asiatic Lily.

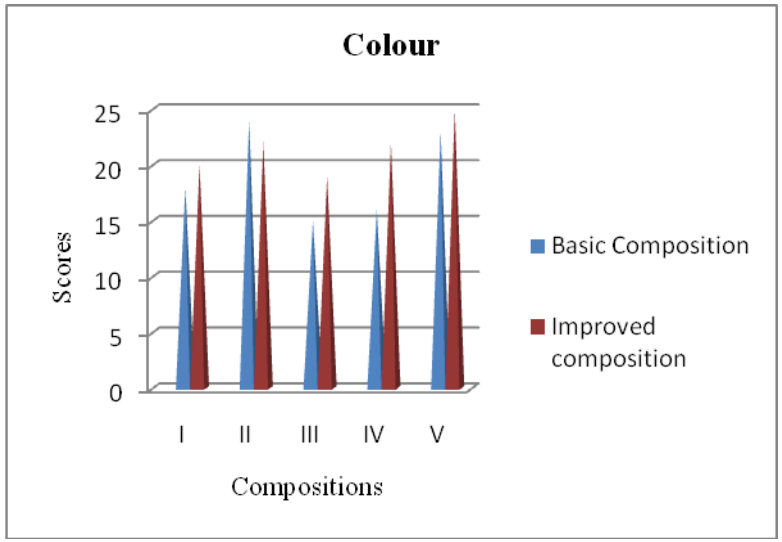
Experts panel scores (Table 4.5) on qualitative parameters of Asiatic Lily treated and freeze dried with basic five compositions (BC), revealed that scores for the colour, Texture, form and appearance was found to have lesser score than improved composition (IC). Among the five basic and improved compositions, Composition-V received the maximum score points for colour, form and appearance. However form scored least with score with basic composition treatments as the flowers were shrinked.

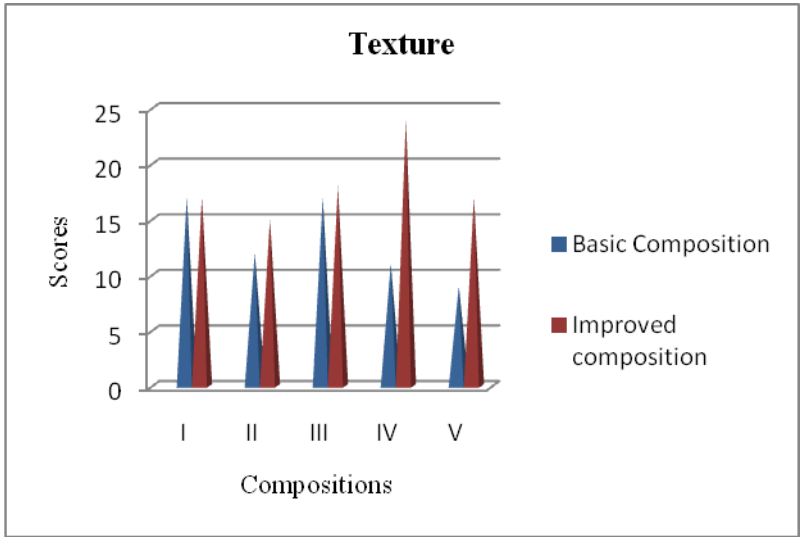
Results emerged out of the analysis coincides with the research reported by Sierra and John (1982) where silicone treatment emerges with better quality of flower.. It was reported that neither the silicone fluid or resin play any part in the colour preservation of the flowers but they do affect the physical and biological properties involved in the resistance of the flowers to withstand mechanical and environmental stresses, essentially rough handling, humidity and temperature. The same effect was seen in Anthurium where with the use of silicon resin and fluid in composition V resulted in flowers with less resistance to breakage and retains the form without altering the shape of the petals.

Reference		Treatment of Asiatic Lily Flower with Different Compositions				
		**Experiment -1 Basic compositions**					
Fresh flower			Composition-I	Composition-II	Composition-III	Composition-IV	Composition-V
H 11 S 73% B 84%			H 19 S 100% B 63%	H 15 S 71% B 87%	H 17 S 86% B 59%	H 18 S 90% B 75%	H 10 S 100% B 80%
Orange(Chilean Fire)			Red(Sangria)	Orange(Sorbus)	Brown(Saddle Brown)	Red(Rust)	Red(Free Speech Red)
			B-9.6 A-1.2 M-87%	B-11.2 A-0.8 M-93%	B-9.8 A-0.8 M-92%	B-9 A-0.8 M-91%	B-7 A-0.8 M-88%
		**Experiment -2 Improved composition with shatter resistant Polymer**					
Freeze Dried			Composition-I	Composition-II	Composition-III	Composition-IV	Composition-V
H 14 S 77% B 90%			**H 16 S 53% B 63%**	**H 14 S 77% B 85%**	**H 24 S 82% B 75%**	**H 18 S 78 % B 58%**	**H 29 S 99% B 60%**
Orange(Sorbus)			Orange (Sante Fe)	Orange(Chilean Fire)	**Red(Sangria)**	**Orange (Rich Gold)**	Orange (Tawny)

			B-7.4 A-0.4 M-94%	B-9.8 A-0.4 M-96%	B-7 A-0.6 M-91%	B-8.2 A-0.5 M-94%	B-7.8 A-0.7 M-91%

Figure 4.10. Effect of treatments on Asiatic Lily.





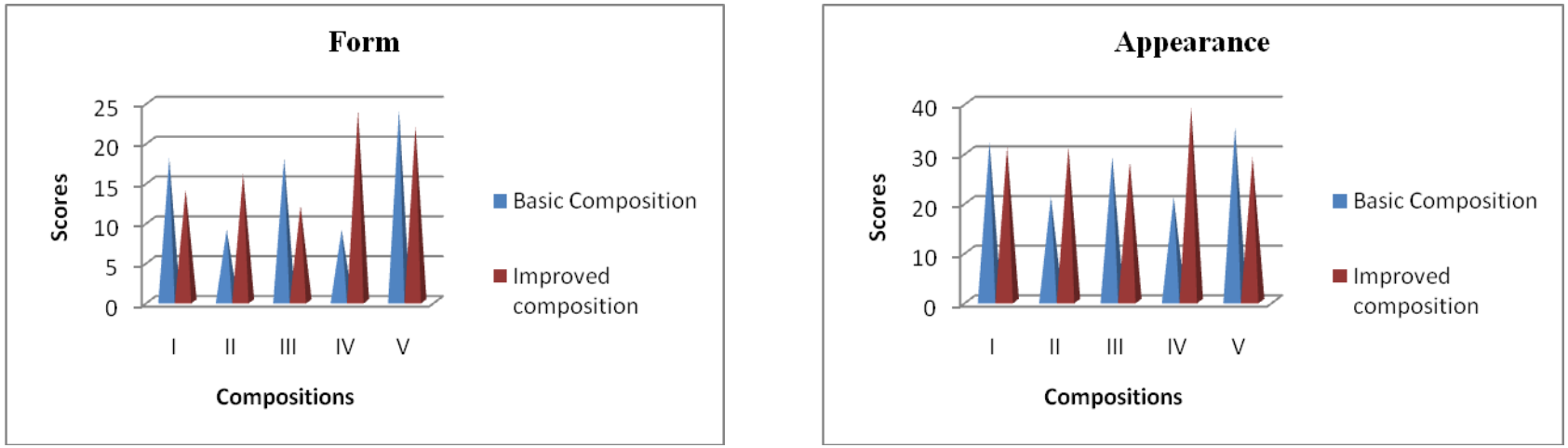


Figure 4.11. Score values for colour, texture, form and appearance of Asiatic Lily.

4.2.4 Effect of treatments on Orchid:

Bright violet colour Orchid was tested to explore the suitability of different compositions. The picture of fresh Orchid, Orchid freeze dried without any treatment, effect of treatments on experiment I and II on freeze dried Orchid, the colour variables measured in terms of Hue (H), Saturation (S) and Brightness (B), the name of hue and colour based on HSB values and moisture loss in different treatments are shown in Figure 4.12. Illustrations presented in this Table for Orchid flower with and without treatments, showed the marked variation in terms of colour, form, shape and texture. Freeze dried Orchid without any treatment resulted in colour loss, over dried and brittle textured, without gloss and sheen, though it retained form. This highlights the importance of pre-treatment for retaining the inherent qualities of flower.

Experiment I and II had a strong influence on colour, form, shape and texture of the flower. Only Composition V retained violet hue while the other compositions changed the hue to red and brown. It was also observed that irrespective of composition, all the flowers appeared dull, dry and brittle. In the case of improved composition, every flower turned red hue, thought flowers looked brighter. Even among this ser of compound, Composition V retained the qualities of flowers close to reference flower except for mild deviation in colour.

In all the treatments the moisture loss percentage varied between 80%-91% in all the flowers and it remained consistent between experiments. Basic compositions resulted in excessive dryness in comparison to improved compositions.

From the above analysis it can noted that colour, texture and moisture content were influenced by the chemical composition used in both the treatments. Only composition V retained colour and the same composition with shatter resistant co-polymer retained gloss and form. However, texture of the flower was not comparable to natural flower.

Table 4.7. Physical Observation score of Freeze Dried Orchid

Physical Observation Score	Composition -I		Composition -II		Composition -III		Composition -IV		Compositio n-V	
	BC	**IC**	**BC**	**IC**	**BC**	**IC**	**BC**	**IC**	**BC**	**IC**
Colour	15	**20**	15	**25**	15	**19**	13	**21**	18	**27**
Texture	13	**20**	16	**19**	12	**19**	12	**21**	16	**19**
Form	14	**26**	17	**24**	14	**23**	15	**27**	21	**24**
Appearance	23	**36**	28	**35**	25	**31**	18	**36**	34	**39**
Total	65	**102**	76	**103**	66	**92**	58	**105**	89	**109**

Table 4.8 ANOVA - One way Classification Table for Orchid

ANOVA **Within Experiment-I**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	430.6	3	143.5333	11.16991	0.0003*	3.238872
Within Groups	205.6	16	12.85			
Total	636.2	19				

ANOVA **Within Experiment-II**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	714.55	3	238.1833	40.37006	1.0868*	3.238872
Within Groups	94.4	16	5.9			
Total	808.95	19				

ANOVA **Between Experiment-I & Experiment-II**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1344.5	3	448.1666	34.138807	1.2577*	2.86626
Within Groups	472.6	36	13.1277			
Total	1817.1	39				

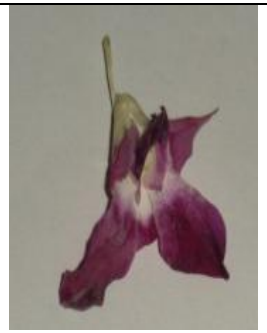
* - Significant difference at 5 percent level

These scores were statistically analysed to establish the influence of treatments on overall quality of flowers. Table 4.8. (Anova one-way classification table) on Orchid

revealed that there was significant difference in the quality of flowers within treatments and between treatments. The Mean sum of squares is largest for within Experiment-II between groups coinciding with the physical observations made and its least for within Experiment-I between groups. The Mean sum of squares is second largest for between Experiment -I and Experiment-II, between groups It was hypothesized that pre-treatment has no significant difference on the overall quality of freeze-dried exotic flowers so the null hypothesis is rejected. Since calculated value of F is greater than the table value of F, null hypothesis is rejected. From this analysis, it can be drawn that the choice of chemicals influenced the quality of freeze dried Orchid.

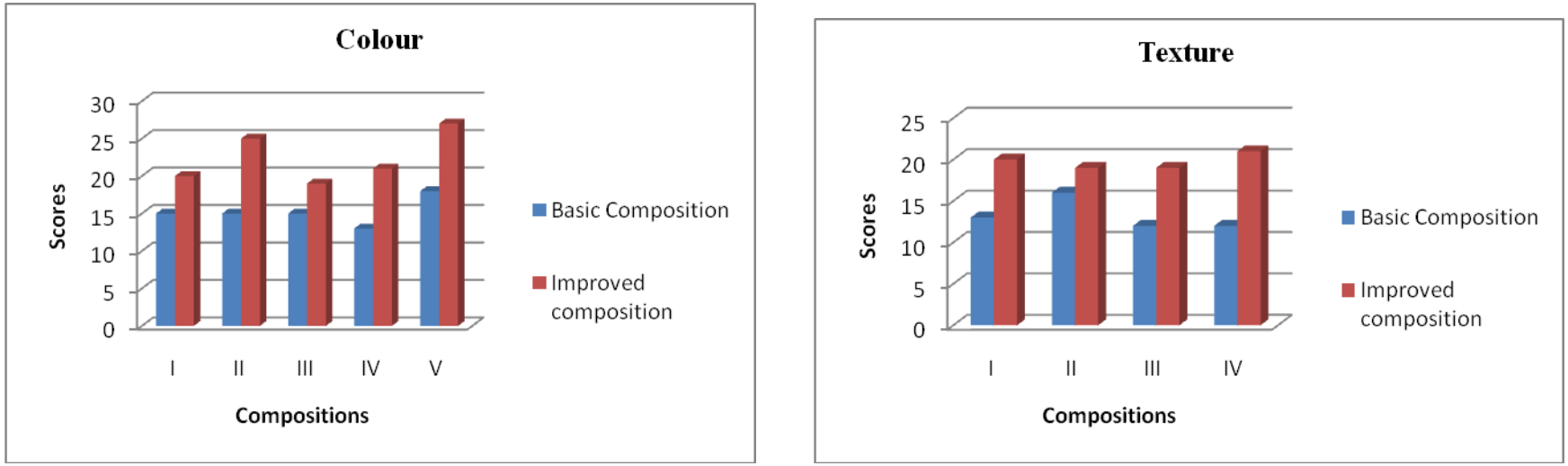
Expert's views (Table 4.7) obtained through score on qualitative parameters of Orchid revealed that scores for the colour, texture, form and appearance of the flowers treated with basic composition, were lesser than improved composition. Among the five basic and improved compositions, Composition-V received the maximum score points for colour and appearance. However texture scored least score irrespective of the treatment as the flowers were hard and dry.

A study conducted by Lee (2000) revealed that the solution for treating the Orchids may also contain an emollient such as glycerol or lanolin to maintain the petals in a non-brittle condition and a buffer which may, for example, comprise citric acid or sodium citrate. One specific solution that can be used for treating most orchid species comprises tertiary butyl alcohol 93.8%; glycerol 3%, citric acid, thiourea and polyvinyl alcohol3%

Reference		Treatment of Orchid Flower with Different Compositions					
		**Experiment -1** **Basic compositions**					
Fresh flower			Composition-I	Composition-II	Composition-III	Composition-IV	Composition-V
H 298 S 84% B 53%			H 309 S 45% B 35%	H 353S 79% B 35%	H 307 S 32% B 31%	H 345 S 80% B 35%	H 327 S 28% B 37%
Violet(Persian Indigo)			Brown (Aubergine)	Red(Pohutukawa)	Brown (Seal brown)	Red(Pohutukawa)	Violet(Finn)
			B-2.2 A-0.2 %-91%	B-1.6 A-0.2 %-88%	B-1.6 A-0.2 %-88%	B-2 A-0.2 %-90%	B-2 A-0.2 %-90%
		**Experiment -2** **Improved compositions with**					
Freeze Dried			Composition-I	Composition-II	Composition-III	Composition-IV	Composition-V
H 300 S 100% B 50%			H 334 S 76% B 33%	H 329 S 61% B 48%	H 342 S 72% B 32%	H 336 S 86% B 34%	H 334 S 78% B 38%

Violet(Purple)			Red(Pohutukawa)	Red(Flirt)	Red(Pohutukawa)	Red(Falu Red)	Red(Pohutukawa)
			B-3.2 A-0.6 M %-81%	B-2 A-0.4 M%-80%	B-3 A-0.2 M%-93%	B-2.6 A-0.4 M %-85%	B-2 A-0.4 M %-80%

Figure 4.12. Effect of treatments on Orchid.



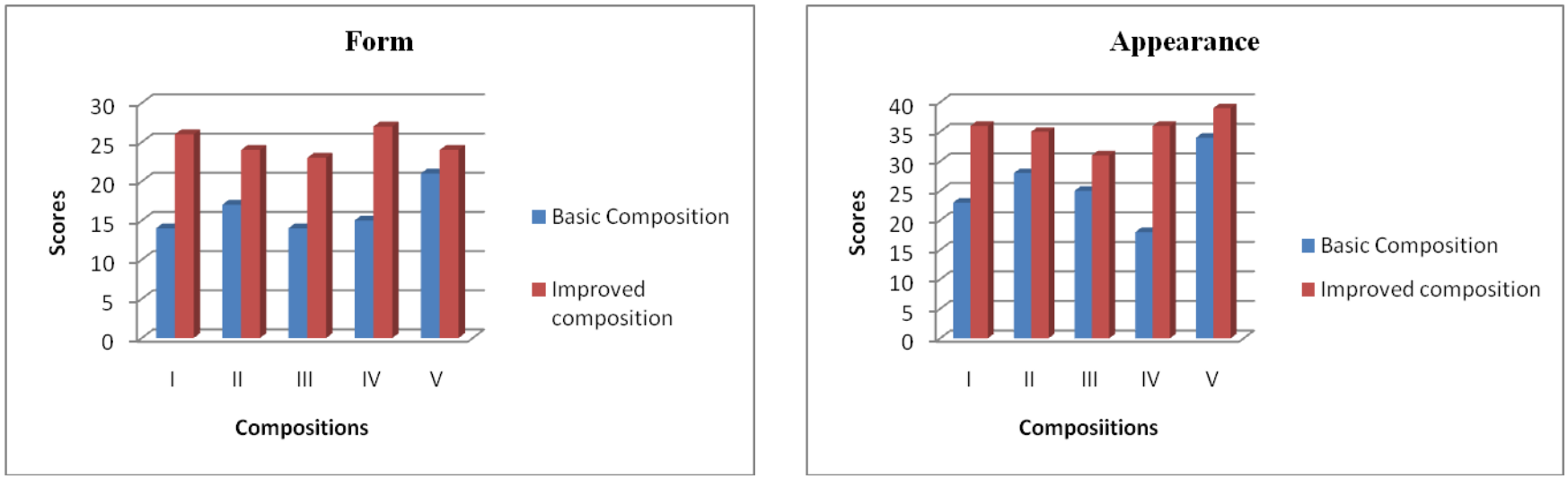


Figure 4.13. Score values for colour, texture, form and appearance of Orchid.

4.2.5 Effect of treatments on Statice :

Bright Purple colour Statice was tested to explore the suitability of different compositions. The picture of fresh Statice, Statice freeze dried without any treatment, effect of treatments on experiment I and II on freeze dried Statice, the colour variables measured in terms of Hue (H), Saturation (S) and Brightness (B), the name of hue and colour based on HSB values and moisture loss in different treatments are shown in Figure 4.14. Illustrations presented in this Table for Statice flower with and without treatments, showed the marked variation in terms of colour, form, shape and texture. Freeze dried Statice without any treatment resulted in colour loss, over dried and brittle textured, without lustre, though it retained form. This highlights the importance of pre-treatment for retaining the inherent qualities of flower.

Experiment I with basic compositions showed variations in colour and texture but there were only minor changes in form and shape. Flowers treated with basic composition have retained the natural hue but appeared to differ in their shades. Flowers treated with composition-II and IV appeared closer to natural flower because of presence of Citric acid and Thiourea, while the other three compositions changed the shade of the hue. The main function of the ingredient, thiourea, is played as a role to prevent the pigment coming out of the plant Wei *et al.* (2010). A study conducted by Sellegaard (1995) found that the presence of citric acid provides the plants with a natural colour. It was also observed that irrespective of composition, all the flowers appeared luscious. This proves that chemical used in different composition had influence on the quality of flowers.

Statice treated with shatter resistant polymer in Experiment II, resulted in having all flowers in violet hue, but looked very dull and dryness was more than the above observation. Among these, composition V retained the softness close to reference flower due to the presence of Silicone fluid and Silicone resin. Though Composition I turned darker in colour, flowers were found to be soft and did not shrunk when compared to the other compositions.

In all the treatments the moisture loss percentage varied between 72%-93% in all the flowers and it did not remain consistent between experiments. Improved compositions resulted in excessive dryness in comparison to basic compositions.

From the above analysis it can be noted that colour, texture and moisture content were influenced by the choice of chemicals in both the treatments. The basic composition II and IV was found to produce more natural looking flower. Though composition V in Experiment II was soft in texture, the inherent colour and lusciousness desired in Statice was lacking.

Table 4.9. Physical Observation score of Freeze Dried Statice

Physical Observation Score	Comp-I		Comp-II		Comp-III		Comp-IV		Comp-V	
	BC	IC	BC	IC	BC	IC	BC	IC	BC	IC
Colour	16	**17**	21	**17**	15	**13**	22	**15**	16	**19**
Texture	16	**16**	15	**15**	19	**12**	19	**15**	20	**21**
Form	22	**19**	23	**18**	23	**15**	22	**17**	22	**16**
Appearance	33	**29**	38	**26**	34	**25**	36	**24**	37	**28**
Total	87	**81**	97	**76**	91	**65**	99	**71**	95	**84**

Table 4.10. ANOVA - One way Classification Table for Statice

ANOVA **Within Experiment-I**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1051.75	3	350.5833	70.824*	1.87000	3.238872
Within Groups	79.2	16	4.95			
Total	1130.95	19				

ANOVA **Within Experiment-II**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	383.75	3	127.9167	22.540*	0.000005	3.238872
Within Groups	90.8	16	5.675			
Total	474.55	19				

ANOVA **Between Experiment-I & Experiment-II**

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1344.5	3	448.1666	34.1388*	1.25776	2.86626
Within Groups	472.6	36	13.1277			
Total	1817.1	39				

* - Significant difference at 5 percent level

These scores were statistically analysed to establish the influence of treatments on overall quality of flowers. Table 4.10. (Anova one-way classification table) on Statice revealed that there was significant difference in the quality of flowers within treatments and between treatments. The Mean sum of squares is largest for within Experiment-I between groups coinciding with the physical observations made and its least for within Experiment-II between groups. The Mean sum of squares is second largest for between Experiment -I and Experiment-II, between groups It was hypothesized that pre-treatment has no significant difference on the overall quality of freeze-dried exotic flowers so the null hypothesis is rejected. Since calculated value of F is greater than the table value of F, null hypothesis is rejected. From this analysis, it can be drawn that the choice of chemicals influenced the quality of freeze dried Statice.

Expert's panel scores (Table 4.9) on qualitative parameters of Statice treated and freeze dried with basic five compositions revealed that scores for the colour, texture, form and appearance was found to have higher score than improved composition. Among the five basic compositions, Composition-II received the maximum score points for overall appearance. However texture scored least in improved compositions as the flowers were hard and dry.

Results emerged out of the analysis coincides with the research reported by Sierra and John (1982) where silicone treatment emerges with better quality of flower. The same significant result was seen in Anthurium and Asiatic Lily. It was reported that neither the silicone fluid or resin play any part in the colour preservation of the flowers but they do affect the physical and biological properties involved in the resistance of the flowers to withstand mechanical and environmental stresses, essentially rough handling, humidity and temperature.

Reference		Treatment of Statice Flower with Different Compositions					
		**Experiment -1 Basic compositions**					
Fresh flower			Composition-I	Composition-II	Composition-III	Composition-IV	Composition-V
H 281 S 34% B 74%			H 265 S 43% B 85%	H 280 S 63% B 56%	H 288 S 66% B 47%	H 279 S 57% B 55%	H 290 S 61% B 30%
Violet(Mountain's Majesty)			Violet(Medium Purple)	Violet(Vivid Violet)	Violet(Blue Diamond)	Violet(Vivid Violet)	Violet(Blackcurrant)
			B-17.8 A-2.6 M-85%	B-20.8 A-4.2 M-80%	B-20.2 A-4.4 M-78%	B-18 A-5 M- 72%	B-14.6 A-4 M-73%
		**Experiment -2 Improved composition with shatter resistant Polymer**					
Freeze Dried			Composition-I	Composition-II	Composition-III	Composition-IV	Composition-V
H 279 S 37% B 57%			H 264 S 49% B 33%	H 263 S 49% B 29%	H 266 S 43% B 27%	H 318 S 60% B 34%	H 260 S 34% B 27%
Violet(Affair)			Violet(Cherry Pie)	Violet(ViolentViolet)	Violet(Tolopea)	Violet(Palatinate Purple)	Violet(Jagger)
			B-3.6 A-1 M-72%	B-5.6 A-0.4 M-93%	B-4.4 A-2 M-54%	B-4 A-1.6 M-60%	B-3.8 A-1.6 M-58%

Figure 4.14. Effect of treatments on Statice.

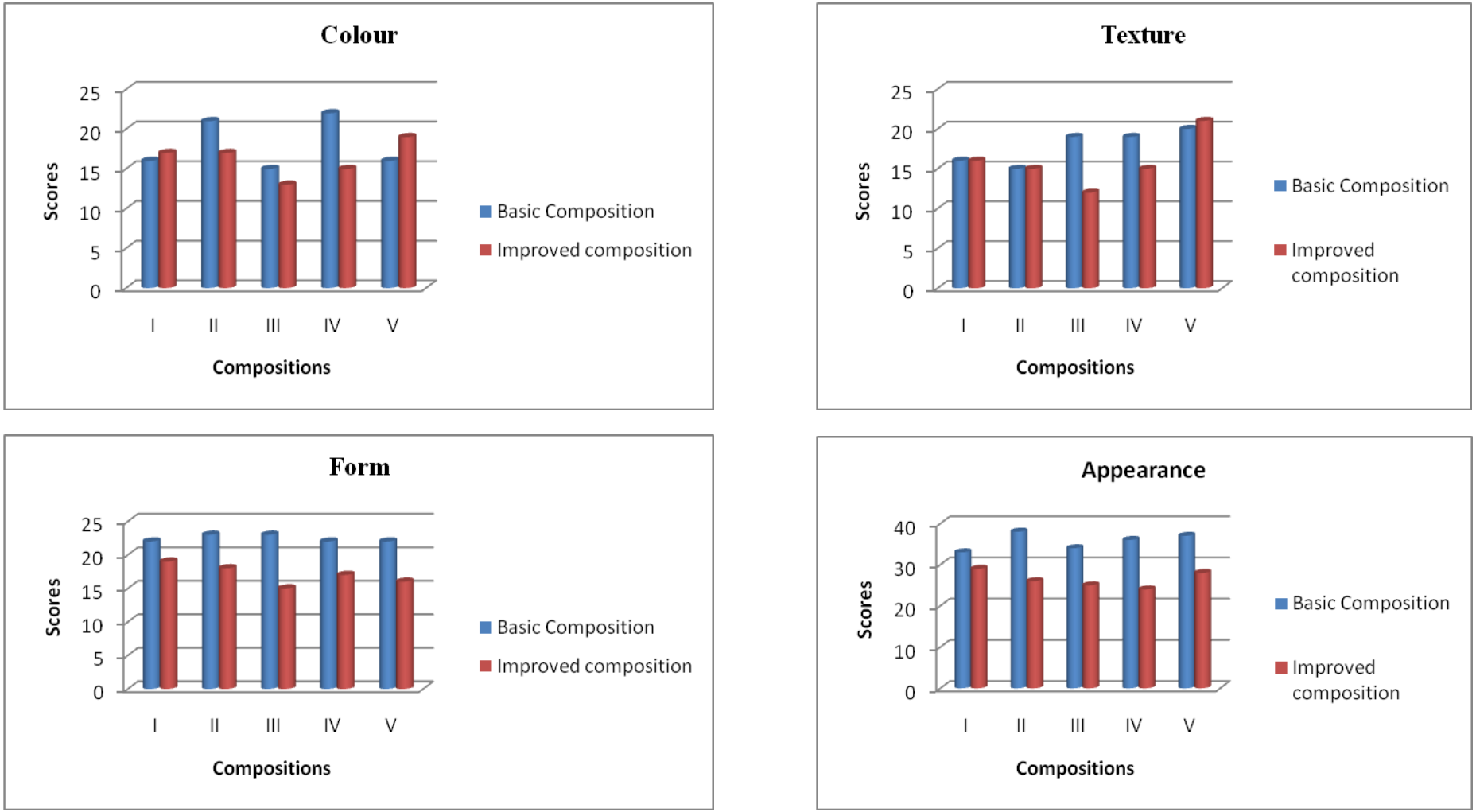


Figure 4.15. Score values for colour, texture, form and appearance of Statice.

4.3 Effect of Selected Pre-treatments on Freeze Dried Exotic flowers

The results emerged out of the experiments conducted with exotic flowers using selected pre-treatments showed that a blend of chemicals in different treatments resulted in retaining most of the desirable qualities of flowers. Table 4.11. shows the details about the composition which were suitable and less suitable and not suitable for the flowers selected for the research. Scores below each composition are the total scores of all variables for each flower i.e Colour, Form, Texture and Appearance (30+30+ 30+ 45) brought forward from previous tables.

Table 4.11. Physical observation score for the selected Freeze Dried Exotic flowers

S.No	Type of Exotic Flower	Basic Composition(BC)						Improved Composition (IC)				
		I	**II**	**III**	**IV**	**V**		**I**	**II**	**III**	**IV**	**V**
1	**Anthurium**	66	66	66	72	88		107	103	98	117	117
2	**Bird of Paradise**	68	64	59	72	58		83	65	85	100	73
3	**Asiatic Lily**	85	66	79	87	91		82	84	77	109	93
4	**Orchid**	65	76	66	58	89		102	103	92	105	109
5	**Statice**	87	97	91	99	95		81	76	65	71	84

From the table above, it can be seen that Anthurium and Orchid got a maximum score from composition V (IC) while Bird of paradise and Asiatic lily got a maximum score from Composition IV (IC). Statice got maximum score from Composition IV (BC). It can be inferred from this table that, Anthurium, Bird of Paradise, Asiatic lily and orchid have thick petals and have shine and this quality was attainable with improved composition while Statice being soft and less glossy, was best with the basic composition.

It can also be observed that among the basic compositions, composition V had received highest scores for Anthurium (88), Asiatic lily (91) and Orchid (89) and retained the inherent qualities of the flowers and these qualities were further enhanced with improved composition. This is probably due to the presence of Silicone fluid being an environmental fixer, that adds shine and gloss to the texture of petal. The findings reveal that improved composition was not suitable for the flower Statice, as it was soft

and had less gloss. Shatter resistant polymer was found to be more ideal for all flowers which have thick petals and has shiny texture.

From the above analysis of effect of selected treatment on the preservation of exotic flowers, it can be drawn that, flowers that were treated with five basic compositions were the blend of different chemicals. Composition I and II had only three chemicals and this was a blend of dehydrant, pigment fixative and colour fixative with pH value of 5-5.5. Composition III and IV had 6 -7 solvents consisting of blend of harsh and mild dehydrant, pigment fixative, colour preservative and pH buffers with pH value between 5.5 – 6.0 and Composition V had a blend of all 14 solvents having a harsh and mild dehydrant, pigment fixative, colour preservatives, environmental and biological fixatives, mordents, modifiers, and buffers. It was found that flowers were found to be brittle and dry except in Statice. To overcome the brittleness and shatter resistance, each of these combinations were treated with a co-polymer and these improved compositions were tested for getting flowers more suitable to retain the desired qualities. The resulting outcome could not arrive at a satisfactory quality of the texture. These compositions may be further improved to obtain natural looking flowers.

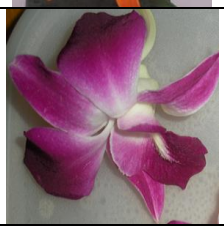
Name of the Flower	Reference Flower	Freeze Dried flower
Anthurium		
Bird of Paradise		
Asiatic Lily		
Orchid		
Statice		

Figure 4.16. Effect of selected treatments on Freeze Dried Exotic flowers.

4.4 Evaluating the effect of different packaging methods of Freeze Dried Exotic Flowers

Preserved flowers, although dry, are now more fragile. Hence, preserved flowers needs to be properly stored in order to protect from environmental factors like heat, humidity, dust and UV rays. Storage can be sometimes challenging, especially because one wrong move can altogether ruin the preserved ones. In order to protect the preserved flowers, three different simple storage methods were used in this study, viz polythene covers, zip lock bags and air tight boxes. Figure 4.17 shows the impact of packaging methods on freeze dried exotic flowers. The score assigned by expert panel for colour, form, texture and physical appearance were used for assessing the suitability of packaging method on the quality of freeze dried flowers. The result in (Table 4.12) shows the score of the reference flower and freeze dried flowers, for each variable.

Freeze-dried Anthurium: These flowers had been stored in polythene cover and zip lock bag and had showed the changes in colour, form, shape and texture and had traces of moisture and this may be the reason for the changes. Anthurium stored in these resulted in colour loss, soft papery texture, without gloss and sheen. Whereas, Anthurium packed in air tight container, did not show any variation, except of tears in petal edges. Small tares may be due overlapping flowers and due to poor handling of over dried flowers. In spite, the flowers stored in air-tight boxes resulted in getting higher score than the flowers stored in polythene cover and zip lock bags These scores when statistically analysed, and the results showed that there is significant difference in the quality of flowers due to different packaging methods.

From the above analysis it can be noted that the flowers packed in air tight container found to be better as these were protected from direct heat, moisture, dust etc. Rengasamy *et al*. (1999) reported that selection of proper packaging, giving proper cushioning and use of moisture barrier packaging materials are of prime consideration in dry flower industry. Boxes should be free from insects since they chew the soft tissue and flower petals shatter making the material unsuitable.

Freeze dried Bird of Paradise: The colour of the Bird of Paradise stored in polythene cover appeared faded and fungus growth was seen. Similarly, flowers stored in zip lock bag also developed patches on green bract of the flower turning it darker. These plastic sachets had traces of moisture and this may be the reason for the changes. Flowers

stored in air tight container were found to be brighter. Flowers stored in air tight container scored higher values on than those stored in polythene covers and zip lock bags. The statistical analysis on these scores revealed that there was significant difference in the quality of flowers due to different packaging methods. Trinklein (2000) recommended various pest control measures against the household insects moving into the boxes during storage and use of silicone packs for prevention of humidity

Freeze dried Asiatic Lily: Flowers stored in polythene cover and zip lock bag resulted in shattering of petals. It was also observed that these had traces of moisture. Asiatic Lilies packed in air tight container retained their colour but petals were loose. This may be due to excessive dryness of flowers in freeze drying process. Experts scores were higher for air-tight box for colour. These scores obtained were statistically analysed and the results revealed that there was significant difference in the quality of flowers in different packaging methods.

Freeze dried Orchids: The colour of Orchid was faded when stored in polythene cover and appeared dull. Flowers in zip lock bag changed to a darker shade and were hard, and wilted and also crushed. Flowers stored in air tight container were found retaining the same quality as reference flower. Scores on qualitative parameters of Orchid revealed that flowers stored in air tight container scored higher values than those stored in plastic sleeves. Statistical analysis on this also revealed that there was significant difference in the quality of flowers due to different packaging methods.

Freeze dried Statice: The colour of the Statice stored in polythene cover was faded and appeared dull. The green stems of the flower turned completely brown and indicative of the influence of moisture. The colour of the flowers changed from purple to violet when stored in zip lock bag. Flowers stored in air tight container were found to be of good quality. Flowers stored in air tight container scored higher values. Scores were statistically analysed and revealed there was significant difference in the quality of flowers due to different packaging methods.

Table 4.12. Physical observation score of freeze dried Exotic flowers in different packaging methods

		Reference Flower	Polythene Cover	Zip lock bag	Air Tight Container
Anthurium	Colour	**27**	18	18	24
	Texture	**22**	15	15	20
	Form	**27**	9	15	18
	Appearance	**41**	9	12	27
	Total	***117***	*51*	*60*	*89*
5% Level of Significance		F Calculated value = 8.19			
		Reference Flower	**Polythene Cover**	**Zip lock bag**	**Air Tight Container**
Bird Of Paradise	Colour	**24**	18	15	21
	Texture	**21**	12	12	18
	Form	**19**	15	15	18
	Appearance	**36**	12	12	30
	Total	***100***	*57*	*54*	*87*
5% Level of Significance		F Calculated value = 5.03			
		Reference Flower	**Polythene Cover**	**Zip lock bag**	**Air Tight Container**
Asiatic Lily	Colour	**22**	15	12	18
	Texture	**24**	18	15	24
	Form	**24**	15	9	18
	Appearance	**39**	15	24	18
	Total	***109***	*63*	*60*	*78*
5% Level of Significance		F Calculated value =4.35			

Type of Exotic Flower	Reference flower**	Reference Flower	Polythene Cover	Zip lock Bag	Air Tight Container
Orchid	Colour				
Anthurium	T		24	15	27
	F			1	
	A			1	
		39	15	1	
	Total				
		109	*78*	*54*	*92*
5% Level of Significance		F Calculated value = 4.73			




		Reference Flower	Polythene Cover	Zip lock bag	Air Tight Container
Statice	Colour	**22**	15	12	22
	Texture	**19**	12	21	16
	Form	**22**	21	21	22
	Appearance	**36**	12	24	30
	Total	***99***	*60*	*78*	*90*
5% Level of Significance		F Calculated value = 3.57			

Bird Of Paradise				
Asiatic Lily				
Orchid				
Statice				

Figure 4.17. Freeze dried Exotic flowers in different packaging material

**Flower treated with Composition scored highest value

Results emerged out of the above analysis coincides with the research reported by Bull (1997) claiming that the dried flowers should not be stored in plastic covers. This is because inserting in polythene covers and zip lock bag caused moisture build up and it ruined the flowers. It is evidenced from the present study that storage conditions significantly influenced the physical appearance on storage. Use of air tight container resulted in flowers with less resistance to breakage and retained the brightness of the freeze dried flower. A research by Plomaritis (2004) suggested that for storing the dried flowers for later use, it should be sealed in airtight containers such as tins or plastic boxes and also sealed with masking tape. Gordon (2004) and Louise and Jennings (1997) opined that covering dried flowers with a clear plastic spray, acrylic or lacquer or chemical preservatives will preserve the colour and make them more durable and moisture resistant.

Figure 4.18. Presentation of Freeze dried Exotic flowers in display cases

The preserved flowers were impressively arranged in display cases for see the sights of the final output of the research. At the end of a month, flower remained the same without any change (Figure 4.18).

From this analysis it can be concluded that the inherent qualities retained by dehydrated flowers through freeze drying process needs proper storage conditions to protect from environmental factors. The reason for change in quality of the freeze dried flowers may be due to deferred pH values. An attempt to display freeze dried flowers in display cases like glass case and wooden frames resulted in retaining the freshness and remained attractive. However further protection of these through post-preservation treatments may further enrich the quality of flowers.

Chapter V

SUMMARY AND CONCLUSION

Flowers are loved by all for their beauty. Since time immemorial, people use flowers for a wide range of events and functions that, cumulatively, encompass one's lifetime. This is used as a vehicle for the expression of wishes and thoughts. The importance of flowers runs deeper than their practical use. Flowers are the ultimate decorating accessory, in homes and other establishments as these bring the vivid beauty of nature to the comfort and warmth of indoor climate. Exotic flowers are stunning visually and these are used to produce best floral arrangements all over the world. Exotic flowers hold a special place in the hearts of flower lovers due to their breathtaking fragrance and exquisite beauty. But these grow on in certain geographical locations and are seasonal. Also, flower's beauty and fragrance are short-lived. Desire to enjoy the beauty of these and especially the precious ones turn temporary. Most of us hope for flowers that will never fade or ephemeral.

Attempts have been made to recreate or retain the beauty of flowers with artificial flowers and with fresh flowers. Artificial flowers, typically made from plastic or silk, do not successfully capture the beauty of a fresh flower. Fresh flowers may be preserved by drying, but these methods drastically alter the appearance of the flower and increase its frailty. Moreover, dried flowers do not last in areas of high humidity. Accordingly, there has been a need for a novel method to preserve fresh cut flowers and the preserved flowers produced there from which substantially retain the appearance, size, shape and colour of the uncut fresh flower. Freeze-drying is a relatively new preservation process for the preserved plant material industry. The main advantage of freeze-drying is that it results in products that appear almost like the fresh originals. The beauty and value of the freeze dried flowers are that they can be kept and cherished for years, which survive the cold of winter and heat of summer.

Hence the present study on “Effect of Selected Preservation Treatments on the Quality of Exotic Flowers in Floral Freeze Dryer” was proposed with the following objectives:

4) **To standardize the preservation treatments suitable for selected exotic flowers in freeze drying process.**

5) **To study the effect of treatments on the qualitative characteristics of selected flowers.**
6) **To evaluate the effect of different packaging methods in retaining the qualitative characteristics of freeze dried flowers.**

The experimental research design was adopted in this investigation to explore the effect of selected preservation treatments on the quality of Exotic Flowers in floral freeze dryer. For conducting this research, Department of Resource Management and Consumer Sciences, College of Home Science, Hyderabad, Acharya N.G.Ranga Agricultural University, which has been working on flower preservation through freeze drying process for the last two years, were chosen for conducting this research. Through purposive sampling method, five varieties of exotic flowers with brilliant colour and shape were identified which are locally available in Hyderabad City for at least 3-4 months in a year. These were Anthurium, Bird of paradise, Asiatic Lily, Orchids and Statice. Fresh and fully bloomed flowers suitable for freeze drying process were selected and hydrated for regaining the overall appearance of flower before pre-treatment and freeze drying process. The colour of the fresh flower was analysed through colour analyser to explore the hue and name of the colour. Also, weights of the flowers were recorded before commencing the pre-treatment process

Preservation of flowers in freeze-dryer starts with Pre-treatments. Towards this 14 chemical solvents which were identified to play a crucial role on flower preservation were tested on exotic flowers, to study their behaviour on flowers. These chemical solvents blended into different compositions and standardised in the on-going Freeze dried flowers research project of the department. Five compositions were selected for use in this research for pre-treatment of flowers. Composition I and II had three solvents having a blend of dehydrant, pigment fixative and colour fixative with pH value of 5-5.5. Composition III and IV had 6 -7 solvents consisting of blend of harsh and mild dehydrant, pigment fixative, colour preservative and pH buffers with pH value between 5.5 – 6.0 and composition V had all the blend of 14 solvents with pH value between6.5-7.0, consisting of blend of harsh and mild dehydrant, pigment fixative, colour preservatives, environmental and biological fixatives, mordents, modifiers, and buffers. These five basic compositions were used for Experiment I. To overcome the brittleness and shatter resistance, each of these combinations were blend with a co-polymer and these improvement compositions were used for Experiment II. Each flower was dipped individually in the selected composition and was kept for evaporation in the floral trays

before transferring to the freezing chamber for dehydration. Each cycle of final experiment in floral freeze dryer took 10-12 days. On completion of freeze drying cycles, flowers were removed from floral freeze dryer and analyzed for measuring the qualitative characteristics such as colour, form, texture and appearance of freeze dried flowers. These four parameters were fixed as variables for evaluation of flowers. For colour analysis, Adobe Photoshop software which has pantone colour system was used to measure colour parameters H, S, and B at selected location on a flower. For analysing moisture loss, the weight of flowers was weighed after the experiment. As all the variables were qualitative, observation technique was study the changes. The treatment that attained maximum scores was used for production of more quantity of flowers and was stored for one month in three selected packaging methods i.e., polythene covers, zip-lock bags and air tight containers to evaluate their effects on the keeping quality of flowers.

Flowers emerged out of the experiments were evaluated by the experts to the measure the changes observed in flowers after freeze drying and also to evaluate the effect of different packaging methods on the physical characteristics of flowers viz., colour, form, texture and appearance through physical observation. For physical observation of qualitative parameters, two observation tools (rating scale) were developed. For this study, "Analysis of Variance – One Way Classification" was used to interpret the qualitative data to know the effect of selected treatments and between treatments on the quality of exotic flowers in floral freeze dryer.

Results emerged out of the experiments

Effect of Chemical solvents on Exotic flowers:

A set of 14 different chemical solutions were tested on floral petals to study its effect to hold in colour and open the cell structure of the flower, as this helps during the freeze-drying process.

Results revealed that each of these chemical reacted differently on colour, texture and appearance of flower petals. Tertiary butyl alcohol, 1 – Propanol, and 2 – Propanol were found to open cell structure and dissolved colour pigments and dehydrate petals. Citric acid, Sodium Citrate, Cupric sulphate, Aluminium Sulphate, and Sodium Formaldehyde Sulfoxylate, Thiourea, Phenol, Propionic acid retained colour pigments while silicone resin and silicone fluid formed glossy shied on the surface.

From the study it was also found that that Citric acid, Sodium citrate, Sodium formaldehyde Sulphoxylate, Cupric sulphate was suitable to retain red colour pigments of Anthurium while t-butyl alcohol, 1-propanol and 2-propanol were found suitable for dehydration. Silicon fluid retained colour and texture while the resin turned the petal fluffy. For petals of Bird of Paradise, Sodium Formaldehyde Sulphoxylate, Citric acid, Thiourea, Aluminium sulphate and Sodium citrate were suitable to retain the orange colour pigments. For Asiatic Lily, Citric acid, Aluminium sulphate, Sodium citrate and Silicone resin were suitable to retain the orange colour pigments. For Orchid flower, 2-propanol, Aluminium sulphate and Citric acid were suitable to retain violet colour pigments. Violet colour in Statice flower was retained by Aluminium sulphate and Sodium citrate. For all the petals and flowers t-butyl alcohol, 1-propanol and 2-propanol were found suitable for dehydration and Silicon fluid and Silicone resin retained the glossy effect.

Effect of selected treatments on Exotic flowers:

Anthurium: In Experiment I flowers treated with composition-II, IV and V retained red hue. It was also observed that irrespective of composition, all the flowers appeared dull, dry and brittle. Anthurium treated with shatter resistant polymer in Experiment II, resulted in having all flowers in red hue, and looked brighter. Even among these, composition V retained all the qualities of flowers close to reference flower, except for change in texture. Composition V(IC) scored maximum points for colour and texture among all the compositions.

Bird Of Paradise: Flower treated with composition-III in Experiment I retained orange. Flowers in this experiment did not retain the green colour bract of the flower as patches were found on it. When treated with shatter resistant polymer in Experiment II, resulted in having all flowers in orange hue and composition-V in red hue and looked brighter than basic compositions. Though Composition II, III and IV retained colour, flowers were found to have creases. Composition I (IC) scored maximum points for colour, texture and appearance among all the compositions.

Asiatic Lily: In Experiment I flowers treated with composition-II retained orange hue while the compositions I, IV and V changed the hue to red. It was also observed all the flowers appeared dry and brittle. In Experiment II, all flowers resulted

in having orange hue, and composition-III in red hue. Composition-IV(IC) scored maximum for texture and appearance. . Composition-V(IC) scored maximum for colour.

Orchid: Violet hue of orchid was retained with composition V in Experiment I, while the compositions-II and IV changed the hue to red, compositions-I and III changed the hue to brown. It was also observed that irrespective of composition, all the flowers appeared dull, dry and brittle. In Experiment II, all flowers were in red hue, but looked brighter. Composition- IV and V retained the qualities of flowers close to reference flower. Though Composition I, II and III retained red hue, flowers were found to have changes in form and appearance. Composition-V(IC) scored maximum for colour and appearance.

Statice: Experiment I flowers treated with basic composition have retained the natural hue but appeared to differ in their shades. Flowers treated with composition-II and IV appeared closer to natural flower while the other three compositions changed the shade of the hue. In Experiment II, all flowers resulted in having violet hue, but looked very dull. Among these, composition I and V retained the softness.

Composition V treated with shatter resistant compound was found to be an ideal composition for Anthurium, Asiatic Lily and Orchid as it has 14 different solvents performing having their own influences which has an effect on the overall quality of the Exotic flowers. Weight loss was found to be 85-92% in different flowers after freeze drying.

The treated flowers were evaluated by the experts through physical observation to confirm with the observations made on colour, texture, form and appearance. Irrespective of all treatments, texture scored low as compared to colour, form and appearance. Results emerged out of the ANOVA one way classification analysis, on the scores attained for all the variables in both the experiments approved that there is significant difference for all the flowers between and within the treatments at 5% level of significance.

It is evident from the present study that different packaging methods significantly influenced the overall quality of the exotic flowers on storage. Flowers stored in air tight plastic containers proved to be better than those stored by inserting in polythene covers with respect to retention of colour, texture form and appearance on

storage. In Anthurium, moisture re-absorption was found when stored in polythene cover and zip-lock bag. They resulted in change in texture (papery) and on touching them they disintegrated. Polythene cover and zip-lock bag proved to be incompatible for Bird of Paradise as growth of moulds were seen on few petals and some petals of this flower became over dried and brittle. Asiatic Lily did not perform much in all the three packaging methods. Orchids when stored in Polythene cover became faded and in zip-lock bag the colour of the flowers changed which was not desirable. Statice showed obvious changes when stored in polythene cover. They became dried and stems turned brown. Like in Orchids, statice stored in zip-lock bag the colour of the flowers changed. The findings from this study reveal that air tight packaging method proved to be good for Anthurium, Bird of Paradise, Orchid and Statice as they retained their qualitative characteristic.

The present study has confirmed that treatments influence the quality of flowers in freeze drying process. The chemicals used in the preparation of composition have influence on inherent qualities of preserved flowers. Flowers treated with combination of dehydrating alcohols, biological or tissue preservatives, environmental fixers, biological fixatives, buffers, mordant's and modifiers resulted in getting better quality of flowers. However change in chemical composition to improve texture of flower needs further research. Preserved flowers stored in air tight containers yielded better results that plastic sleeves. Post-preservation of preserved flowers can further improve the quality of exotic flowers.

Conclusion

Exotic flowers hold a special place in the hearts of flower lovers due to their breathtaking fragrance and exquisite beauty. But flower's beauty and fragrance are short-lived. Desire to enjoy the beauty of these and especially the precious ones turn are dream of many. Attempts have been made to recreate or retain the beauty of flowers goes back many years. Aesthetically arranged dried flowers and foliage provides artistic decorations for use in the home, and in the office and sundry other business establishments. Studying the effect of selected preservative treatments on exotic flowers with more recent technique of freeze drying in floral freeze dryer was taken up. To produce a high quality freeze dried flower, treatments with chemicals was found to be necessary. Five chemical compositions were tested on five different exotic flowers and pre-treatment helps to retain the colour, form and appearance except texture. Use of

appropriate control over the desired parameters can further enhance the quality of flowers hence suitable for marketing. Further research to improve the textural quality can result in near-real quality to natural flowers. Lacunae found in this study can be taken up for further research. Flowers have a universal appeal and they are never out of fashion. This fundamental fact translates into a big opportunity for people in the flower business.

Implications of the Study

- Create new entrepreneurship opportunities for the farmers to cultivate more varieties of exotic flowers domestic and export consumption and preservation into everlasting flowers.
- Women can be trained in soft skill of handling floral freeze driers, to generate marketable ever-lasting end-products out of the technology for inland and export sales.
- Well packed freeze dried blooms can be created for different occasions and can be sold in the markets to meet the needs of the consumers as large numbers are willing to spend time and energy for creating exclusive flower arrangements as an accessory for decorating both residential and commercial interiors.

Areas of future research

- Further research can be taken up to explore methodologies for improving texture of seasonal and exotic flowers in Floral Freeze Dryer.
- This study was restricted to few Exotic flowers. Hence the same preservation treatments can be studied on various colours, species and other varieties of exotic flowers (ex: Ginger, Lotus, Lily etc) in freeze dryer.
- A study on methodologies for post- preservation of freeze dried flowers may be taken up.
- A study on different packaging methods for freeze dried flowers may be undertaken.

LITERATURE CITED

Adiga, D.J., Patil, M.S., Kulkarni, S.B and Reddy, B.S. 2004. Studies on drying of Ixora for value addition. National Symposium on Recent Trends and Future Strategies in Ornamental Horticulture, Dec.1-4, 2004, Indian Society of Ornamental Horticulture, New Delhi, Abstracts, 117.

Alagumani, T.M., Anjugam and Rajesh, R. 1997. Performance of Flower Crops vis-à-vis Field Crops in Madurai District, Tamil Nadu. Indian Journal of Agricultural Economics, 52(3): 620-21

Almeida, A.S., Alves, R.E., Paiva, W.O., Lima MAC, Almeida JBSA. 2002. Quality and Storage of Beehive Ginger (Zingiber spectabilis) Following Postharvest Treatment with 1-MCP. Proceedings American Society of . Horticultural science. 46:110-111.

Barley, J. 2009. Technical Note: Basic principles of freeze drying for sp scientific, sp industries inc

Barua, A . 2005. ExpressIndia-Indiafloriculture industry cash in on exotic flowers http:// www.expressindia.com/news/fullstory.php

Berd House Gallery. 2011. The Meaning Of The Flowers According to Feng-Shui, http://www.berdhousegallery.com/tag/flower-arrangements

Bhutani, J. C. 1990. Capturing nature, a way with flower "everlastings". Indian Horticulture, 34(3): 15-18.

Bhutani, J. C. 1995. Drying of flowers and floral craft. *Advances in Horticulture*, 12: 1053-1058.

Bull, B.1997. Drying flowers for everlasting beauty. http://www.garden.org/nga/edit/articles/dryflower.qua.

Champoux, J. 1997. Tips and home remedies. http://www.keepsmilin.com/tips.html.

Chen, W., Gast, K and Smithey, S. 2000. 'The effects of different freeze-drying processes on the moisture content, color, and physical strength of roses and carnation' Scientia Horticulture Volume 84 Issues 3-4:321-332

Chikayo, I., Masataka, O., Tetsuya, A and Yasuyuki, S. 2002. 'Comparative Study on the Optimum Drying Method of Dried Flowers for Multipurpose Use' Journal of the Society of Agricultural Structures Japan Vol 3 No 2:123-130

Christie, G. 2010. Florage Freeze Dried Flowers, http://www.florage.com/freeze-dried-flowers.html

Creswell, J. 2003. Research Design. Qualitative and Quantitative Approaches, California, Sage.

Dalgleish. 2010. Freeze drying machine full report. http://www.seminarprojects.com/Thread-freeze-drying-machine-full-report

Datta, S.K. 1999, Dehydrated flowers and foliage and floral craft. Floriculture and Landscaping (eds.) T.K. Bose, R.G. Maiti, R.S. Dhua and P. Das. 696-703.

Datta, S.K. 2004. Dehydration of flowers: A new diversified product for floriculture industry. Emerging Trends in Ornamental Horticulture, 2004, Indian Society of Ornamental Horticulture. 157-161.

Dyk, J.V.1998. Drying flowers. http://www.ipm.iastate.edu /ipm/hortnews/1998/dryflower.html.

Eco India. 2008. Flora in India. http:// www.ecoindia.com/flora

Ferguson, V. 2001. Storing Your Dried Flowers http://www.suite101.com/article.cfm/dried_flower_crafts/70473

Funnel, K. A and Heins, R. O. 1998 Plant growth regulators reduce post production leaf yellowing of potted asiflorum lilies. *Hortscience* 33:1036 – 1039.

GoodHousekeeping.1999. Preserving Beautiful Blooms. http://www.goodhousekeeping.com/.

Gordon, B., 2004. *Drying roses for Fun*. http://www.ars.org/drying.html.

Gouin, F.R. 1994. Preserving flowers and leaves. http://www.msue.msu.edu/factsheets.

Ichimura, K.Y., Kawabata, M., Kishmoto, R., Goto and Yamad, K. 2002. Variation with the cultivar in the vase life of cut flowers. *Bull. Natl. Inst. Flor. Sci*., 2: 9–20

Hassan, F.A.S and Gerzson, L. 2002. Effects of 1-MCP (1-methylcyclopropene) on the Vase Life of Chrysanthemum and Carnation Cut Flowers. Int. J. Hort. Sci. 8:29-32.

Hoffman, C.2010. Information About Exotic Flowers October 04, 2010 http://www.ehow.com/facts_7283660_information-exotic-flowers.html

Ito, H.T., Hayashi, M., Hashimoto, K., Miyagawa, S., Nakamura, S., Yazawa .2007. ISHS Acta Horticulturae 804: Europe-Asia Symposium on Quality Management

in Postharvest Systems - Eurasia 2007 Preserving Fresh Flowers with Natural Pigments And Texture

Jain, K .2011. Benson Polymers Limited, New Delhi, India. http://www.polyfix.in/

Jennings, T. A. 2001. Other Applications of Freeze-Drying, Insight Volume 4 Number 12

Joshi ,M. 2005. Chairman, Parliamentary Standing Committee on Commerce, Seventy Sixth Report On Floriculture Presented To The Rajya Sabha On The 22nd December, 2005, Rajya Sabha Secretariat, New Delhi

Kathy, R. 2010. Memories & Memorials.
http://www.memoriesandmemorials.com/index.html

Ketsa, S and Narkbua, N. 2001. Effects of aminooxyacetic acid and sucrose on vase life of cut roses. *Acta Hort.* 543, pp227 – 234.

Kulkarni, S.B., Patil, V.K and Reddy, S.B. 2004. Studies on drying of marigold (*Tagetes erecta*) flowers. *National Symposium on Recent Trends and Future Strategies in Ornamental Horticulture*, Dec.1-4, 2004, Indian Society of Ornamental Horticulture, New Delhi, Abstracts, p.123.

Kumar, A. and Parmar, P. 1998. Preserving flowers and foliage. *Kisan World*, 25: 63.

Laliberte, K. 2004. Preserving summer's beauty. http://www. innogardgardeners.com/index.html

Lee, H.K.2000. Preservation of flowers Patent Number: 2000060937

Lindroth, R.L and Koss, P.A. 1996. Preservation of Salicaceae leaves for phytochemical analyses: Further assessment. *J. Chem Ecol.* 22:pp765–771.

Louise, C. M and Jennings, L. J. 1997. Methods of preserving plant material, Patent Number 5677019

Masaki, H and Takahiro H. 2009. Method for preserving cut flowers, cut flower preservation kit, method for manufacturing processed cut flowers, and processed cut flowers US20090119801

Mnerie,D. 2008. ERASM US programme. lyophilisation, Politehnica University of TimisoaraRomania.http://www2.zf.jcu.cz/public/departments/koz/mezes/lyophilization.pdf

Musgrove, M.B. 1998. Drying and preserving flowers and plant materials for decorative use. http://www.aces.edu /counties.

Nataraj, S.K., Kulkarni, S.B., Gangadharappa, P.M., Reddy, B.S., Hegde, N.K and Mathad, G.V. 2004. Standardisation of drying techniques in Nerium oleander.

National Symposium on Recent Trends and Future Strategies in Ornamental Horticulture, Dec.1-4, 2004, Indian Society of Ornamental Horticulture, New Delhi. Abstracts:121.

Niguel, L. 2002. "Nature's Beauty Flower Preservation - Freeze-dry process http://www.naturesbeauty.us/process.html

Nilsback, M.E and Andrew Zisserman. 2006. A visual vocabulary for flower classification, Volume 2 CVPR06, Publisher: IEEE. 1447-1454

Nowak, J. and Rudnicki, R.M. 1990. 'Postharvest Handling and Storage of Cut Flowers, Florist Greens and Potted Plants' Timber Press, Chapman and Hall, New York. Porthand, Oregan . 210.

Orians, C. M. 1995. Preserving leaves for tannin and phenolic glycoside analyses: A comparison of methods using three willow taxa. *J. Chem. Ecol.* 21:1235–1243.

Pebley W. S., James, S., Baglien .2004. Why freeze Dried Oregon Freeze Dry Inc., Albany, Oregon, USA 2004

Plomaritis, N. 2004. Drying and preserving flowers and leaves. http://www.make-stuff.com.

Prasad, K.V., Choudhary, M.L. and Kumar, S. 2003. The art of drying rose flowers. *Value Addition in Horticulture*, Eds. M.L. Choudhary and K.V. Prasad, Division of Floriculture and Landscaping, IARI, New Delhi, 147-154.

Puri, A. 1995. Economic potential of dried flowers. *Agricultural Marketing*, 36(1): 43-46.

Raghava, S.P.S. 2001. Floriculture – a viable diversification option in agri-business. Indian Horticulture, 45: 41, 44-45.

Raghupathy, R., Amuthan, G and Kailappan, R. 2000. Dried flowers: Significance. Kisan World, 27: 39.

Raj, D. 2003. http://www.techno-preneur.net/ ScienceTechMag/ oct03/flower_floral.htm

Rani, M.S.A., Anbu, S. and Thangaraj, T. 2000. Standardisation of technology for drying flower Plumeria spp. National Seminar on Hi-tech Horticulture, 26-28 June2000, Horticulture Society of India, New Delhi, Abstracts, p.173.

Ranjan, J.K. and Misra, S. 2002. Dried flowers: a way to enjoy their beauty for a long period. Indian Horticulture, 46: 32-33.

Reddy, M. V and Kumari, D. R. 2010. 'Assessing the feasibility of preservation of flowers and foliage in freeze-drying process and market potential' State Plan Unpublished - Annual Report 2009-2010 ANGRAU Hyderabad 11- 12

Reid, M.S. 2002. Non-metabolized cytokinins as growth regulators in post harvest performance of ornamentals. J. Amer. Soc. Hort. Sci. 469. 201 – 205.

Rengasamy, P., Arumugam, T., Jawaharlal, M., Ashok, A.D and Vijayakumar, M.1999. "Dry flowers" – A profitable floriculture industry. Kisan World, 26: 61-62.

SADC Trade Information Brief. 2011. Cut Flowers. http://www.sadctrade.org/tib/cutflowers

Sakamoto, Y. 2010. Method for Producing Preserved Flower and Processing Solution. United States Patent Application 20100251431,

Salunkhe, D.K. 1990. Post-Harvest Biotechnology of Flowers and Ornamental Plants, Springer- Verlag, Berlin. 68-75.

Sell, R. 1993. Dried and fresh-cut flowers. http://www.ndsuext.nodak.edu/extpubs/alt-ag/flowers.html.

Sellegaard, L. E. 1995. Method for preserving flowers, particularly roses. United States Patent Number 5399392

Sierra, R and John, W.B. 1982. Flower Preservation. United states Patent Number 4272571

Sierra, R. 1988. Flower Preservation. United States Patent Number 3046969

Singh, A., Dhaduk, B.K. and Shah, R.R. 2003. Effect of dehydration on post-harvest life and quality of zinnia flowers. Journal of Ornamental Horticulture, 6(2): 141-142.

Singh, D.B. 2003. Exploring export potential of dried wild flowers and their value-added products. Indian Horticulture, 48: 38-40.

Sisler, E.C., Dupille, E., Serek, M. 1996a. Effect of 1 – methylcyclopropene and methylenecyclopropane on Ethylene Binding and Ethylene Action Cut Carnations. Plant Growth Regulation, 18:79-86.

Smith, R.C. 1993. Methods of preserving flowers. http://www.ndsuext.nodak.edu/extpubs/flowers.html.

Sparks, A. 2006. Importance of Flowers. http://interiordec.about.com/od/flowers/a/tropicalflowers.htm

Sumangala, H. P. and Amrik Singh Sidhu. 2011. Scientist, Div. of Ornamental Crops, IIHR, Bengaluru. Indian Plants for Landscape Gardening http://www.floriculturetoday.in/indian-plants-for-landscape-gardening.html

Susan. 1990. *Dried Flowers*. Merchants Ltd. Ferry House, London.144.

Tandler, J. 2010. Method For Increasing Long-Term Storage Of Cut Flowers, USPTO Patent Application 20090092740It

Thomas, M.R. 1999. Preserved cellular structures, United States Patent Number 5911917, http://www.freepatentsonline.com

Thomler, J. 1997.Drying flowers and leaves. http://www.nectar.com.au/jascraig/craft/driedf/htm.

Trinklein, D. 2000. Drying flowers and foliage for arrangements. http://www.muextension.missouri.edu/explore/agguides/hort/go6540.htm.

Trinklein. 2006. Drying Flowers and Foliage for Arrangements G6540, Published by University of Missouri Extension, University of Missouri.

Toshio, A., Yoshihiro, U and Tadashi. 2005. Treatment method for preservation of plant leaves US Patent number 6960363

Truly Madly Deeply florists. 2002. http:// www.trulymadlydeeply.biz/ - United Kingdom

Verma, S.S. 2008. Science Tech Entrepreneur. February 2008. http://www.techno-preneur.net/informationdesk/sciencetechmagazine/2008/feb08/Plastic%20Flowers.pdf

World Is Natural .2009. http;//world-is-natural.org/page14/page14/html

Wei, C.,Hung, Z., Lin, Chi-Chang. 2010. Compositions and Methods for Preserving Colors and Patterns of Plants. Publication *number*: US 2011/0071112 A1

White, P., Tijia, B And Sheehan, M.R. 2002. Drying and preserving plant materials. http://edis.ifas.ufl.edu/body-ep004.

Wilkins, H.F and Desborough, S.L.1986. Cryo-drying of Dianthus Caryophyllus L. Flowers. Post-harvest Physiology of Ornamentals. Acta Hort. 181:477-481

Yan, P. 1999. How to dry flowers – An overview. http://www.dried flowersdirect.com.

Zencirkiran, M. 2010. Scientific Research and Essays Vol. 5(17) Academic Journals. 2409-2412.

Characteristics of Flowers	Treatments						
	I	II	III	IV	V	VI	VII
Color accuracy							
No Change in Hue							
No Change in intensity							
No Change in value							
Texture							
Soft to feel							
Soft to look							
Life likeness							
Form							
Retained shape							
No change in size							
All petals intact							
Appearance							
Looks brighter / duller than original							
Looks lighter / darker than original							
No Wilting							
No fading							
Retained natural look							

APPENDICES

Appendix A

Score card for Assessment of qualitative characteristics of Freeze Dried flower

Name of the flower: _____ Sample No: _____ Date: _____

Scale for Evaluation : 3 - Very true 2 -Acceptable 1 - Unacceptable

Appendix B

Score card for Assessment of qualitative characteristics of Freeze Dried flower stored in different packaging methods

Name of the flower: _____ Sample No: _____ Date: _____

	Reference Flower	Polythene cover	Ziplock bag	Air tight container
Colour				
Texture				
Form				
Appearance				

Scale for Evaluation : 3- No change 2- Small change 1- Total change