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Standardizing dehydration technique for *Cleretum bellidiforme* and *Calendula officinalis*

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Abstract
The present experiment was conducted on standardizing dehydration technique for *Cleretum bellidiforme* and *Calendula officinalis* by using embedding drying methods in room temperature and hot air oven at 55 °C. The experiment consisted of 10 treatments with 3 replications designed in completely randomized design. Treatments used were as; T_1- fine silica (room temperature), T_2- fine silica+borax (room temperature), T_3-borax (room temperature), T_4-soil (room temperature), T_5-sand (room temperature), T_6-sand (hot air oven at 55 °C), T_7-borax (hot air oven at 55 °C), T_8- fine silica (hot air oven at 55°C), T_9-fine silica+ borax (hot air oven at 55 °C), T_{10}- soil (hot air oven at 55 °C). In case of *Cleretum bellidiforme* dehydration, maximum reduction in flower weight (0.41g) was recorded in treatment T_8 (fine silica embedding in hot air oven at 55 °C), T_7 (0.41g) (borax embedding in hot air oven at 55˚ C) and T_9 (0.41g) (fine silica+ borax embedding in hot air oven at 55˚ C). Minimum reduction in flower weight (0.27g) was recorded in treatment T_5 (sand embedding, room temperature). Maximum flower diameter reduction (0.50 mm) after drying was reported in T_8 (fine silica embedding in hot air oven at 55 ˚C) and minimum flower diameter reduction (0.10 mm) was recorded in T_5 (sand embedding, room temperature). In case of *Calendulla officinalis*, maximum flower weight reduction (0.95g) was reported in T_8 (silica embedding in hot air oven at 55˚C), which was found to be statistically superior to all other treatment. Minimum flower weight reduction (0.72g) was recorded in T_4 (soil embedding, room temperature) and T_5 (sand embedding, room temperature). Maximum flower diameter reduction (0.50 mm) was recorded in T_4 (soil embedding, room temperature), which was found to be statistically highest diameter reduction from all other treatment. Minimum flower diameter reduction (0.10 mm) was recorded in T_8 (fine silica embedding in hot air oven at 55 ˚C) and T_1 (fine silica embedding in room temperature). Among all treatment, embedding drying with silica was found to be best in term of appearance and texture of these flowers after drying.

Keywords: Calendula, dehydration, embedded drying, ice plant, living stone daisy

Introduction
Flowers are wonderful creation of nature regarded as a symbol of love, beauty and a paradigm of life. Flowers are synonyms of delight and blissfulness due to their power to make people happy and cheerful. In the recent years, the demand of flowers all over the world is increasing for decoration with eco-friendly things, but the availability is the limiting factor. Decoration with fresh flowers and foliages is also expensive, short lived and time consuming. The dried flowers or plant parts are natural, comparatively inexpensive and have everlasting value with year around availability (Safeena *et al*., 2006) [12]. By using dehydration technique the charm of ornamental flowers could be enjoyed for several years without disturbing their colour and form (Bhutani, 1990; Datta, 1999; Ranjan and Misra, 2002) [3, 6, 11]. The flower drying techniques involve reducing moisture content of flowers to a point at which biochemical changes are minimized maintaining cell structure, pigment level and flower shape (Singh *et al*., 2003) [13]. Preserving plant materials in dry form considered as a form of artistic expression that was very popular in Victorian ages. Dry flower arrangement have been popular in Europe and Americans used to brighten their homes by using dry flowers especially during dark winter months as early as 1700 (Brown *et al*., 2013) [4]. Earlier, Herbalists used dry flowers obtained through pressing for the preparation of herbarium (Lawrence, 1969) [9]. Now, this process is moving to an art to science and has become a major economic activity on a global scale (Verma *et al*., 2012) [14]. The dried ornamental plants offer wide range qualities like novelty, longetivity, aesthetic properties and year round availability (Joycee, 1998) [8]. Recently, dried flowers are used for interior decoration as substitute of fresh flowers.
Dry flower industry in India is more than 40 years old mainly due to its high export value. Dry flowers were introduced initially by the British in Calcutta due to its nearness to north-east and

eastern regions where exotic and diverse blooms were available in nature (Bhattacharjee and (Bhattacharjee and De, 2003) [2]. India exports 71% dry flowers to USA, Japan, Australia, Russia and Europe (De *et al*., 2016) [7]. Exporting companies at Kolkata in West Bengal, Tuticorin in Tamilnadu, Mumbai in Maharastra and Hyderabad in Andhra Pradesh are earning 10-15 times higher returns than domestic markets (Verma *et al*., 2012) [14]. Drying of Flowers can be done by different drying methods like air drying, sun drying, press drying, oven drying, freeze drying, glycerin method of preservation, microwave drying and embedded drying. Different decorative floral craft items like cards, floral segments, wall hangings, landscapes, calendars, potpourris etc. could be made by using these dried flowers (Bhutani, 1990) [3]. This industry generates ample job opportunity to thousands of men and women. Thus, there is large potential to develop the dry flower industry to provide employment mainly to house wives and rural women.

Cleretum bellidiforme (living stone daisy) and *Calendula officinalis* (calendula, pot marigold) are winter season annuals and their self- life is very less. After harvesting, living stone daisy flowers stay fresh for only one day. In order to use these flower for longer duration and year around purpose for decorations and many other purposes drying of these annuals is preferred. Embedding drying is one of the best methods of drying flower with respect to maintaining the texture and appearance of flower and cost involved as well. Based on this knowledge and importance of dry flower industry the objective of present investigation was: To find out the best dehydration technique for the drying of *Cleretum bellidiforme* and *Calendula officinalis.*

Material and Methods

The experiment was carried out at Lovely Professional University, Phagwara from March 3 to April 22, 2021 in the horticultural laboratory of Agriculture block. Winter season annual: living stone daisy (*Cleretum bellidiforme*) and calendula (*Calendula officinalis*) were sown and cultivated in agriculture farm of LPU, phagwara. The healthy, fresh, disease free, uniform flowers of these crops were harvested at their commercial stage. *Cleretum bellidiforme* flowers were harvested at afternoon hours between 12-1 pm and *Calendula officinallis* flowers were harvested in the morning hour 8-10am from the agriculture farm of Lovely professional university. Immediately after harvesting they were precooled at 4°C. Separate experiments for *Cleretum bellidiforme* and *Calendula officinalis* were laid out in a completely randomized design with three repetitions. Experiment consisted of five different embedding material (fine silica powder, boric acid, fine silica and boric mixture in the ratio of 1:1, sand and soil) used for drying of these flower at two different temperature (room temperature and in hot air oven at 55 °C). Treatments used were as; T_1- fine silica (room temperature), T_2-fine silica+borax (room temperature), T_3-borax (room temperature), T_4-soil (room temperature), T_5-sand (room temperature), T_6- sand (hot air oven at 55 °C), T_7-borax (hot air oven at 55 °C), T_8- fine silica (hot air oven at 55 °C), T_9- fine silica+ borax (hot air oven at 55 °C),T_{10}- soil (hot air oven at 55 °C).

About one inch layer of the desiccant as per treatment was poured at the bottom of container and the flower stems were pushed into the medium. The flowers were kept in erect position. Desiccants were then gently and gradually poured all around and over the flower up around 5cm above, so as to fill all the crevices in between the petals without disturbing the shape of flowers. As per treatment these container per kept in room temperature as well as hot air oven. For Hot air oven drying of flowers are kept in electrically operated hot air oven at temperature 55 ˚C. In all the treatment of drying, after dehydration the container were tilted for removing the desiccants over and around the flowers and the dried flowers from trays were picked up by hand, cleaned by inverting them and tapping the stems with fingers slowly and gently. Observations on weight reduction (fresh flower weight - dry flower weight), reduction in flower diameter (fresh flower diameter - dry flower diameter) were recorded. The colour and texture of flowers after drying were given rating 1, 2, 3, 4 and 5 (1-Very poor, 2-Poor, 3-Good, 4-Very good, 5-Excellent).

Result and Discussion

Present experiment revealed the significant effect of different embedding material for dehydration of *Cleretum bellidiforme* and *Calendula officinalis* at different temperature on dry flower parameter of these flowers. Data presented in Table 1 showed the significant effect of different dehydration treatment on drying of *Cleretum bellidiforme* flowers. Maximum reduction in flower weight (0.41g) was recorded in treatment T_8 (fine silica embedding in hot air oven at 55 °C), T_7 (borax embedding in hot air oven at 55˚ C) and T_9 (fine silica+ borax embedding in hot air oven at 55˚C). Minimum reduction in flower weight (0.27g) was recorded in treatment T_5 (sand embedding in room temperature). Maximum flower diameter reduction (0.50 mm) after drying was reported in T_8 (fine silica embedding in hot air oven at 55 ˚C), which was found to be statistically superior then all other treatment. Minimum flower diameter reduction (0.10 mm) was recorded in T_5 (sand embedding in room temperature) and found to be statistically at par with T_2 (0.13 mm) and T_{10} (0.13 mm). *Cleretum bellidiforme* flowers dried with fine silica embedding material at room temperature and hot air oven at 55°C were found to be excellent in texture as well as appearance after drying. Soil and sand when used as embedding material showed poor result in term of texture and appearance of dry flower of *Cleretum bellidiforme* used in this experiment (Fig 1).

Data presented in Table 2 showed the significant effect of different dehydration treatment on drying of *Calendulla officinalis.* Maximum flower weight reduction (0.95g) was reported in T_8 (silica embedding in hot air oven at 55˚C), which was found to be statistically superior to all other treatment. Minimum flower weight reduction (0.72g) was recorded in T_4 (soil embedding, room temperature) and T_5 (sand embedding, room temperature). Minimum flower diameter reduction (0.10 mm) was recorded in T_1 (fine silica powder embedding, room temperature) and T_8 (fine sillica embedding, hot air oven at 55°C). Maximum flower diameter reduction (0.50 mm) was recorded in T_4 (soil embedding at room temperature). Among all treatment, embedding drying with fine silica gel power was found to be best in term of appearance and texture of flower after drying (Fig 2).

It was observed that using silica gel as a dehydration agent, at room temperature and in hot air oven gave good results when compared to other embedding drying methods. Using silica gel as dehydration agent, at 55 ˚C, with duration of 30-72 h, the floral petals became papery in touch in both *Cleretum bellidiforme* and *Calendula officinalis.* The samples did not show colour discoloration and were easy to handle and the

texture was smooth and appearance was also good with no much discoloration. At room temperature silica gel dehydration showed best results followed by Borax, Silica+ borax mixture. Using Borax as dehydration agent at 55˚C in hot air oven had recorded minimum flower brittleness due slow heating effect of borax, and silica+ borax mixture as embedding medium showed similar results of Borax dehydration method. Sand and soil used as dehydration agents showed poor results in both at room temperature and at hot air oven drying at 55 ˚C and also in the texture and appearence. Similar finding has been reported for dehydration of dianthus, china aster (Patel *et al*., 2017) [10], annual chrysanthemum (Dahiya *et al*., 2003) and *Dendranthema grandiflorum* (Bhalla *et al*., 2006) [1]. From the present study, It was concluded that hot air oven drying at 55˚ C with silica gel mixture as the embedding medium is best for production of quality drying flowers of *Cleretum bellidiforme* and *Calendula officinalis*

Table 1: Effect of different drying method on weight reduction, reduction in flower diameter, texture and appearance of *Cleretum bellidiforme*

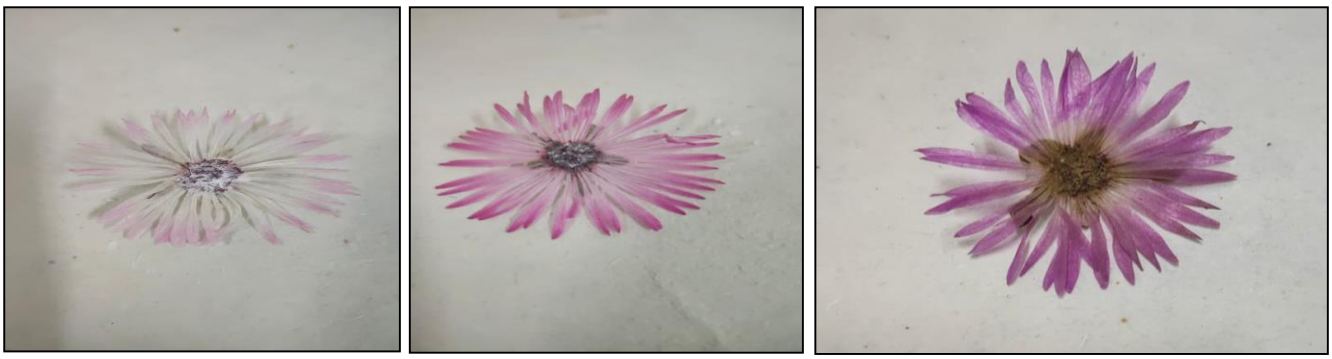
Treatment (embedding material and temperature)	Weight reduction (g)	Reduction in flower diameter (mm)	Texture	Appearance
T_1 (Fine silica powder, room temperature)	0.37^{b}	0.20^{c}	5	5
T_2 [Fine silica powder: Borax (1:1), room temperature]	0.33^{d}	0.13^{cd}	3	4
T_3 (Borax, room temperature)	0.36^{c}	0.20^{c}	4	4
T_4 (Soil, room temperature)	0.31^{e}	0.10^{d}	2	3
T_5 (Sand, room temperature)	0.27^{f}	0.10^{d}	2	2
T_6 (Sand, hot air oven 55 °C)	0.35^{c}	0.17^{cd}	2	3
T_7 (Borax, hot air oven 55 °C)	0.41^{a}	0.33^{b}	4	4
T_8 (Fine silica powder, hot air oven 55 °C)	0.41^{a}	0.50^{a}	5	5
T_9 [Fine silica powder: borax (1:1), hot air oven 55 °C]	0.41^{a}	0.20^{c}	3	4
T_{10} (Soil, hot air oven 55 °C)	0.35^{c}	0.13^{cd}	2	3
CD (5%)	0.01	0.08		

*The colour and texture of flowers after drying were given rating 1, 2, 3, 4 and 5 (1-Very poor, 2-Poor, 3-Good, 4-Very good, 5-Excellent).

Table 2: Effect of different drying method on weight reduction, reduction in flower diameter, texture and appearance of *Calendula officinalis*

Treatment (embedding material and temperature)	Weight reduction (g)	Reduction in flower diameter (mm)	Texture	Appearance
T_1 (Fine silica powder, room temperature)	0.91^{c}	0.10^{e}	5	5
T_2 [Fine silica powder: Borax (1:1), room temperature]	0.85^{d}	0.23^{cd}	4	4
T_3 (Borax, room temperature)	0.90^{c}	0.26^{bc}	4	4
T_4 (Soil, room temperature)	0.72^{g}	0.50^{a}	2	2
T_5 (Sand, room temperature)	0.72^{g}	0.26^{bc}	2	3
T_6 (Sand, hot air oven 55 °C)	0.78^{f}	0.26^{bc}	2	3
T_7 (Borax, hot air oven 55 °C)	0.94^{b}	0.13^{ef}	4	5
T_8 (Fine silica powder, hot air oven 55 °C)	0.95^{a}	0.10^{e}	5	5
T_9 [Fine silica powder: borax (1:1), hot air oven 55 °C]	0.90^{c}	0.16^{de}	4	4
T_{10} (Soil, hot air oven 55 °C)	0.78^{e}	0.33^{b}	1	1
CD (5%)	0.009	0.08		

*The colour and texture of flowers after drying were given rating 1, 2, 3, 4 and 5 (1-Very poor, 2-Poor, 3-Good, 4-Very good, 5-Excellent).



A. B. C.

Fig 1: dehydrated flowers of *Cleretum bellidiforme*: A) Silica embedding in hot air oven at 55˚C, B) Borax embedding in hot air oven at 55˚C, C) Soil embedding in hot air oven at 55˚ C.

A. B. C.

Fig 2: dehydrated flowers of *Calendula officinalis*: A) Silica embedding in hot air oven at 55 ˚C, B) Borax embedding in hot air oven at 55˚C, C) Soil embedding in hot air oven at 55 ˚C.

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