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Embedded drying of spray Chrysanthemum (*Chrysanthemum morifolium* Ramat.) cultivars.

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ABSTRACT

The experiment entitled "Studies on embedded drying of spray chrysanthemum (*Chrysanthemum morifolium* Ramat.) cultivars" was conducted to find out suitable desiccant for embedded drying of spray chrysanthemum cultivars *i.e.* Atom Joya, Pusa Aditya and Yellow Star, embedded in five embedding media *viz.* silica gel (Crystal, Bead and Powder), sand and saw dust in hot air oven at 40 ºC. The minimum time required for drying was shown by cv. Yellow Star (14.56 hrs) and also maximum in colour (3.1) and overall acceptability (2.72). Cv. Pusa Aditya recorded maximum score in colour (3.1), texture (3.16), brittleness (4.28) and shape (3.0). Among the embedding media, Silica gel (Crystal) took minimum time (10.62 hrs) to dry. Silica gel (Bead) scored maximum (3.5) for colour. Silica gel (Powder) scored maximum for texture (4.2), brittleness (4.33), shape (3.9) and overall acceptability (3.53).

1. Introduction

A bouquet of fresh flowers brightens up the space or occasion but unfortunately they are not long lasting. With advancement in the field of science, scientists have found ways to preserve the beauty of the flowers for a longer period of time. Different methods of drying are employed to sustain the beauty and charming appearance of these plants. Dehydration technology eases the entire process of preserving the original colour and shape of the plants parts. Presently, among all the horticultural produce, Indian floricultural industry have more than 70% share in the export of dry flowers and its value added products. Export of dried flowers and plants from India is more than ₹ 100 crore per year (Singh, 2018). The Indian industry risks the loss of its competitiveness to suppliers of other origin for lack of reliable processing technologies. To strengthen the dry flower industry, more research is required as to promote and uplift the industry (Dattatray, 2017). In India, 60% of raw materials are from natural forests and plains, only 40% are cultivated. There is a need to produce high quality dry flowers from commercially available flowers apart from the forest resources to encourage systematic growing of specialized flowers. Dried chrysanthemum flowers are in considerable demand in the global trade (Wilson *et al.*, 2013). Various cultivars of chrysanthemum flower come in wide range of shape, colour and size. Drying the flowers will enhance the growers to gain more value from their products. Structure of the plant parts used, per cent of moisture content, harvesting stage, harvesting time and methods used for drying determines the quality of the dry flower products. Rani and Reddy (2015) stated that method of drying depends on the suitability of the flower; certain methods can be applied only to some flowers. Previous research findings reported that embedding the flowers helps to retain their shape, colour and quality. Embedding is the method of drying in which flowers are dried by embedding in various desiccants such as Silica gel (Crystal, Bead and Powder), Sand, Saw dust, *etc.* Different types of silica gel have been used because the size and shape of the embedding media varies the outcome of the dried flowers with regards to quantitative and qualitative characters. Among the desiccants, sand and saw dust were cost efficient and are easily available. Hence, the following observations were recorded to know the effect of the cultivars using five

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different embedding media on dried chrysanthemum flower qualities *viz.* colour, texture, brittleness, shape and overall acceptability.

2. Materials and Methods

The present investigation was conducted in the Department of Horticulture, School of Agricultural Sciences and Rural Development, Medziphema, Nagaland during the year 2017-2018 to find out suitable desiccant for embedded drying of chrysanthemum cultivars *i.e.* Atom Joya, Pusa Aditya and Yellow Star embedded in five embedding media *viz.* silica gel (Crystal, Bead and Powder), sand and saw dust in hot air oven at 40 ºC. The experiment was laid out in 2 Factorial CRD with three replications and three flowers per replication. Observations were recorded for quantitative *viz.*, fresh weight (g), dry weight (g), percent loss of moisture content (%) and time taken for drying (hrs) and qualitative (colour retention, texture, brittleness, shape retention, overall acceptability) parameters. Percent loss of moisture content was calculated by finding the difference between the fresh and dry weight . Quantitative parameters data was analyzed with Completely Randomized Design (Factorial) with 5% level of significance. Sensory evaluation scores for qualitative parameters were given based on 5 point hedonic scale modified (Peryam, 1957). For colour retention, scores were alloted, *viz.* 5 points (excellent), 4 points (very good), 3 points (good), 2 points (poor) and 1 point (very poor). Texture was evaluated by feel method. The scores were alloted, *viz.* 5 points (smooth), 3 points (medium) and 1 point (rough). For brittleness, scores were allotted based on intactness of the florets *viz.* 5 points (Intact petals), 3 points (slightly brittle) and 1 point (brittle petals). For shape retention, scores were alloted, *viz.* 5 points (excellent), 4 points (very good), 3 points (good), 2 points (poor) and 1 point (very poor).Overall acceptability of flowers was concluded based on the best appearance. The scores were alloted, *viz.* 5 points (excellent), 4 points (very good), 3 points (good), 2 points (poor) and 1 point (very poor). To observe the effect of cultivars, embedding media and their interaction on the qualitative characteristics of dried flower, scores were given accordingly by a panel of five judges and based on the score obtained from the five judges, total score and average for each product was calculated.

3. Results and Discussion

Quantitative characters

It is inferred from Table 1 that there was variations in qualitative parameters of different varieties of flowers embedded with different desiccants. The maximum fresh weight (1.23 g) was recorded in cv. Atom Joya and minimum (0.67 g) in cv. Yellow Star. Similarly, cv. Pusa Aditya exhibited the maximum dry weight (0.29 g) and the minimum dry weight (0.16 g) was observed in cv. Yellow Star. This might be mainly due to inherent varietal variation (Sindhuja *et al.,* 2017). Among the embedding media, sand recorded maximum dry weight (0.28 g) and silica gel (Crystal, Bead and Powder) recorded minimum (0.22 g). For interaction, maximum dry weight (0.34 g) was in cv. Pusa Aditya embedded in saw dust, and minimum (0.13 g) was recorded in cv. Yellow Star embedded in silica gel (Crystal).This was in accordance with the findings of Sindhuja *et al.* (2017) and Sharma *et al.* (2015). Saw dust being light weight does not absorb much amount of water which results in more dry weight. The maximum (77.67%) percent loss of moisture content was observed in cv. Atom Joya which was statistically at par (76.26%) with cv. Yellow Star and minimum (73.74%) was observed in cv. Pusa Aditya. Maximum (78.27%) percent loss of moisture due to embedding media was observed in Silica gel (Crystal) which was found at par with silica gel (Bead) at 77.62% and the minimum (72.29%) was recorded in sand. With regard to the interactions, maximum (82.17%) percent loss of moisture content was observed in cv. Atom Joya dried in Silica gel (Powder) which was found at par with cv. Yellow Star embedded in saw dust and minimum (67.58%) in cv. Yellow Star embedded in sand was recorded. According to reports, mostly flowers embedded in silica gel records maximum moisture loss (Dattatray 2017). Different varieties of flowers took different time to dehydrate in different desiccants. Maximum time (26.40 hrs) takenfor drying was recorded in cv. Atom Joya and minimum (14.56 hrs) in cv. Yellow Star. Among the embedding media, silica gel- Crystal recorded minimum time to dry (10.62 hrs) and sand recorded maximum time (34.09 hrs). For the interaction effect, minimum time (9.33 hrs) was taken by cv. Yellow Star embedded in silica gel (Crystal) while maximum time (56.22 hrs) by cv. Atom Joya embedded in sand. According to White *et al.* (2002) more fleshy flowers and foliage took more time in drying. Silica gel dries flowers quickly (Trinklein, 2000).

Qualitative characters

The qualitative characters are presented in Table 2 showed that all the cultivars varied in colour retention. Maximum score in colour retention (3.1) was observed in cv. Pusa Aditya and cv. Yellow Star and minimum (2.6) was observed in Atom Joya. Among the embedding media, silica gel (Bead) recorded maximum score (3.5) while sawdust recorded minimum score (2.5). Among the interactions, better colour retention of dry chrysanthemum flower (4.2) was observed in C_3M_2 *i.e.* cv. Yellow Star cultivar in beaded silica gel. The least score (1.2) was observed in C_1M_5 *i.e.* cv. Atom Joya flowers dried with sawdust (M_5). For texture among the cultivars, maximum score (3.16) was observed in cv. Pusa Aditya and minimum (2.6) in cv. Atom Joya. The scores on texture due to embedding media was recorded maximum (4.2) in silica gel (Powder) and minimum (1.8) was observed in silica gel (Crystal). Among interactions highest score (4.6) was observed in C_3M_3 *i.e.* cv. Yellow Star cultivar in Silica gel (Powder) and lowest (1.4) was in C_1M_1 *i.e.* cv. Atom Joya cultivar in Silica gel (Crystal). Silica gel (Powder) was found to be ideal for obtaining smooth texture in dried flowers. Similar result was obtained by Safeena and Patil (2013) in Dutch rose cv. 'Lambada' and Nair and Singh (2011) in chrysanthemum flowers. With respect to cultivars, the maximum score (4.28) for brittleness was observed in cv. Pusa Aditya and minimum score (2.6) was observed in cv. Yellow Star. Flowers embedded in embedding media silica gel (Powder) recorded maximum score (4.33) for brittleness and minimum score (3.27) in silica gel (Crystal). The interaction between the cultivars and embedding media also showed effect regarding brittleness of dry chrysanthemum flowers. The highest score for brittleness (4.6) was observed in interaction of C_2M_3 *i.e.* cv. Pusa Aditya cultivar in Silica gel (Powder) and minimum score (1.8) was observed in interaction of C_3M_1 *i.e.* cv. Yellow Star flowers dried in Silica gel (Crystal). This might be due to the strong hygroscopic nature of silica granules (Kumari, 2015). Shape retention of flower differed significantly among the different cultivars. The maximum score (3.0) for shape retention was observed in cv. Pusa Aditya and minimum score (2.4) was observed in cv. Atom Joya. Among the embedding media, maximum score (3.9) was recorded in silica gel (Powder) and minimum score (2.1) in silica gel (Crystal). The data recorded showed that highest score for shape retention of dry chrysanthemum flower (4.2) was observed in interaction of C_2M_3 *i.e.* cv. Pusa Aditya in Silica gel (Powder) and minimum score (1.6) was observed in C_1M_5 *i.e.* cv. Atom Joya in saw dust. Similarly, Safeena *et al.* (2006) and Dhatt *et al.* (2007) reported that silica gel embedded flowers retained better shape. For overall acceptability among the cultivars, maximum score (2.72) was observed in cv. Yellow Star and minimum score (2.28) was observed in cv. Atom Joya. With regard to embedding media, it recorded maximum score (3.53) in Silica gel (Powder) and minimum score (1.6) in sawdust. Among interactions, highest score for overall acceptability of dry chrysanthemum flower (3.8) was observed in interaction of C_2M_3 *i.e.* cv. Pusa Aditya in Silica gel (Powder) and least score (1.2) was observed in C_1M_5 *i.e.* cv. Atom Joya in saw dust. It was revealed that silica gel was the best desiccant for better quality dried flowers for *Dendrobium* orchid in a similar result by Salma (2010). Cultivar Pusa Aditya (C_2) had better colour, shape and texture and was least brittle in comparison to other cultivars and hence was found to the most acceptable cultivar for embedded drying. However, cv. Atom Joya (C_1) secured the least scores in the qualitative parameters and was found to be the least acceptable for embedded drying. Same result was observed by Sindhuja (2015) in carnation cultivars.

4. Conclusion

From the findings of the present investigation it was concluded that different cultivars, embedding media and their interactions affect the quantitative and qualitative parameters of the chrysanthemum flowers during embedded drying. Cultivar Yellow Star gave excellent results in quantitative parameters and in qualitative parameter for colour. However, cv. Pusa Aditya gave better results in retaining the qualitative parameters such as texture, brittleness, shape and overall quality. Silica gel (powder) is best for embedded drying of chrysanthemum flowers.

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Cv. Atom Joya

Cv. Pusa Aditya

Cv. Yellow Star

Fig 1: General view of different cultivars of chrysanthemum at full bloom stage

Cv. Atom Joya in silica gel Powder (C_1M_3)

Cv. Pusa Aditya in silica gel Powder (C_2M_3)

Cv. Yellow Star in silica gel Powder (C_3M_3)

Figure 2. Flowers dried by silica gel Powder (M_3)

Table 1. Effect of cultivars, embedding media and their interaction on quantitative characters of chrysanthemum flower

Cultivars(C)	**Fresh weight (g)**	**Dry weight (g)**	**Percent loss of moisture content (%)**	**Time taken for drying (hours)**
C_1 (Atom Joya)	1.23	0.27	77.67	26.40
C_2 (Pusa Aditya)	1.13	0.29	73.74	18.35
C_3 (Yellow Star)	0.67	0.16	76.26	14.56
SEm±	0.022	0.006	0.79	0.08
CD at 5%	0.062	0.016	2.27	0.22
Embedding media (M)				
M_1 (Silica gel Crystal)		0.22	78.27	10.62
M_2 (Silica gel Bead)		0.22	77.62	11.16
M_3 (Silica gel Powder)		0.22	76.46	20.71
M_4 (Sand)		0.28	72.29	34.09
M_5 (Saw dust)		0.27	74.79	22.29
SEm±		0.007	1.01	0.1
CD at 5%		0.021	2.93	0.28
Interactions (C × M)				
C_1M_1		0.26	77.25	10.39
C_1M_2		0.27	77.07	10.50
C_1M_3		0.21	82.17	27.61
C_1M_4		0.32	74.99	56.22
C_1M_5		0.31	76.85	27.28
C_2M_1		0.26	78.31	12.14
C_2M_2		0.27	76.55	12.83
C_2M_3		0.31	71.46	17.28
C_2M_4		0.29	74.28	28.39
C_2M_5		0.34	68.07	21.14
C_3M_1		0.13	79.26	9.33
C_3M_2		0.14	79.25	10.14
C_3M_3		0.15	75.75	17.25
C_3M_4		0.23	67.58	17.66
C_3M_5		0.14	79.48	18.44
SEm±		0.012	1.76	0.17
CD at 5%		0.035	5.07	0.49
CV %	8.36	8.72	4.01	1.51

Table 2. Effect of cultivars, embedding media and their interaction on qualitative characters of chrysanthemum flower

Cultivars(C)	Colour retention	Texture	Brittleness	Shape retention	Overall acceptability
C_1 (Atom Joya)	2.6	2.60	4.04	2.4	2.28
C_2 (Pusa Aditya)	3.1	3.16	4.28	3.0	2.64
C_3 (Yellow Star)	3.1	2.92	2.6	2.8	2.72
Embedding media (M)					
M_1 (Silica gel Crystal)	2.6	1.80	3.27	2.1	2.07
M_2 (Silica gel Bead)	3.5	2.07	3.53	2.5	2.67
M_3 (Silica gel Powder)	3.1	4.20	4.33	3.9	3.53
M_4 (Sand)	3.0	3.13	3.67	2.3	2.87
M_5 (Saw dust)	2.5	3.27	3.4	2.8	1.6
Interactions (C × M)					
C_1M_1	2.8	1.4	3.8	2.2	2.2
C_1M_2	3.8	2.2	4.2	2.8	2.6
C_1M_3	3.4	3.8	4.2	3.6	3.4
C_1M_4	1.8	2.2	4.2	1.8	2.0
C_1M_5	1.2	3.4	3.8	1.6	1.2
C_2M_1	2.4	1.8	4.2	1.8	1.6
C_2M_2	2.6	2.2	4.2	2.4	2.8
C_2M_3	3.8	4.2	4.6	4.2	3.8
C_2M_4	3.8	3.8	4.2	2.8	3.2
C_2M_5	3.2	3.8	4.2	3.6	1.8
C_3M_1	2.6	2.2	1.8	2.4	2.4
C_3M_2	4.2	1.8	2.2	2.4	2.6
C_3M_3	2.2	4.6	4.2	3.8	3.4
C_3M_4	3.4	3.4	2.6	2.4	3.4
C_3M_5	3.2	2.6	2.2	3.2	1.8