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Full Length Research Paper

Study on dry leaf production of asparagus (*Asparagus densiflorus*)

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The study was undertaken to standardize the technology for dry leaf production in asparagus. The experiment was conducted with twelve treatment combinations consisting of three drying temperature and four embedding media during year 2007. Observations were recorded at an interval of four hours starting from 4th h to optimum drying (constant weight) during drying process. Percent moisture loss and reduction in width (cm) of leaf was significantly highest at higher temperature and silica gel during entire process of drying from 4 - 16th h of drying. The temperature revealed that the low temperature with borax exhibited well maintained smooth surface, less mechanical damage during handling and acceptable colour (aesthetically acceptable).

Key words: Drying temperature, embedding media, asparagus.

INTRODUCTION

Asparagus is known as bridal fern because the leaves are so often used for making the delicate lacy boquets that brides carry on the way to the alter plants grow best in semi shade and when trained onto some kind of a trellis. These species look very beautiful when used in garden both for indoor and outdoor. In window boxes and hanging baskets they simply look beautiful when it blooms with its bright colours. This foliage has short life, just of 2 - 3 days. Dry leaves are gaining popularity amongst floriculturists and buyers, as it is an inexpensive, everlasting and eco friendly product. Hence, these folia-ges were selected for preserving their beauty through dehydration with a view to preserve the beauty and freshness of foliages for much longer period, embedding one to enjoy its beauty even at home as well as in office with an additional benefit of value addition. Therefore, a study was under taken to study the technology for dry leaf production. This technique is developed, which may be easier, efficient and cheaper, dehydration industry of floral produce can provide creative employment to thou-sands of rural people. It can be taken up on small scale industries yielding rewardable results in rural areas. But, this important aspect is totally neglected in research work. Viewing uprising potentials of flower drying trade, its practical utility in our country and gap of research in this aspect, the study was undertaken.

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MATERIALS AND METHODS

The experiment was conducted in the laboratory of Department of Horticulture, College of agriculture, Junagadh Agricultural Univer-sity, Junagadh (Gujarat) India, during the year 2007. Which is situated at altitude of 60 m above the MSL and 80 kms away from the Arabian Sea coast and 21.5°N latitude and 70.5°E longitude? In the study, twelve treatment combinations, consisting of three drying temperature *viz*. 50°C (T_1), 55°C (T_2) and 60°C (T_3) and four media *viz.* Sand (M_1), Sand: Borax (1:1) (M_2), Borax (M_3) and Silica gel (M_4) were evaluated in factorial completely randomized design with three replications. Observations were recorded every four hours up to constant weight (dry leaf) during drying process. The data were statistically analysed as per the method described by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Weight loss and moisture loss

Percent moisture loss was recorded significantly higher under higher temperature 4 - 16th h of drying (Table 1). At higher temperature, rate of moisture loss from leaf tissues (transpiration) was more due to more conduction and convection of heat. Brandenberg et al. (1961) and Alka Singh et al. (2003) also observed similar type of effect in case of seed and Zinnia flower drying respect tively.

Table 1. Effect of temperature and embedding media on percent moisture loss asparagus leaf

Treatments	4th h	8th h	12th h	16th h
(I) Temperature (T)				
Drying at 50°C (T_1)	48.24	63.67	73.47	82.62
Drying at 55°C (T_2)	56.67	69.74	79.00	87.78
Drying at 60°C (T_3)	64.09	75.63	82.83	90.47
S.Em.±	1.07	0.55	0.52	0.41
C.D. at 5%	3.14	1.62	1.53	1.21
(II) Embedding media (M)				
Sand (M_1)	52.20	64.84	74.12	83.24
Sand: Borax (M_2)	54.06	67.81	76.54	85.92
Borax (M_3)	58.29	71.17	79.52	87.95
Silica gel (M_4)	62.78	74.90	83.55	90.74
S.Em.±	1.24	0.64	0.60	0.48
C.D. at 5%	3.62	1.87	1.77	1.40
(III) Interaction (T x M)				
S.Em.±	2.15	1.11	1.05	0.83
C.D. at 5%	NS	NS	NS	NS
C.V.%	6.62	2.77	2.33	1.66

Table 2. Effect of temperature and embedding media on reduction in width (cm) of asparagus leaf.

Treatments	4th h	8th h	12th h	16th h
(I) Temperature (T)				
Drying at 50°C (T_1)	0.070	0.125	0.173	0.244
Drying at 55°C (T_2)	0.085	0.157	0.218	0.310
Drying at 60°C (T_3)	0.100	0.185	0.261	0.355
S.Em.±	0.002	0.004	0.005	0.006
C.D. at 5%	0.007	0.011	0.015	0.017
(II) Embedding media (M)				
Sand (M_1)	0.043	0.093	0.141	0.197
Sand: Borax (M_2)	0.070	0.130	0.170	0.259
Borax (M_3)	0.090	0.170	0.239	0.333
Silica gel (M_4)	0.137	0.230	0.320	0.423
S.Em.±	0.002	0.004	0.006	0.006
C.D. at 5%	0.008	0.013	0.018	0.020
(III) Interaction (T x M)				
S.Em.±	0.005	0.008	0.010	0.011
C.D. at 5%	NS	NS	NS	NS
C.V.%	10.19	8.88	8.64	6.82

Further, it was found that media had also significant effect on per cent moisture loss (Table 1). Maximum per cent moisture loss was recorded in silica gel and minimum in sand during 4th h to 16th h drying. Silica gel has great capacity to absorb moisture so it can absorb moisture up to 30 - 50% of its weight (Brandenberg et al., 1961 and Maureen, 1988). Interaction effect of drying temperature and media on per cent weight and moisture loss were found non significant (Table 1).

Reduction in leaf width

The leaf width was also significantly influenced by drying temperature during all the periods 4 - 16th h (Table 2). These effects were more under higher temperature during 4 - 16th h due to higher loss of moisture. Initially moisture loss from the cells were not enough to produced noticeable decrease in leaf size later on, the effect was highly marked. Kozlik and Boone (1987) also reported excessive shrinkage in *Alnus* species on drying at higher temperature above 230°F, while lower temperature caused less shrinkage.

Similarly media shown significant effect on reduction in leaf size (Table 2). Maximum reduction in leaf size was observed in silica gel followed by borax. Sand gave minimum leaf size was reduction. Reduction in leaf size was occur due to removed moisture molecule from the foliage tissue more intensely, which cause greater

Table 3. Effect of temperature on pigment content (mg/g tissue) of asparagus leaf.

Sample	Chlorophyll mg/g tissue	Carotenes mg/g tissue	Xanthophylls mg/g tissue
Fresh leaf	1.232	0.029	0.042
Dry leaf at 50°C	1.230	0.017	0.036
Dry leaf at 55°C	1.200	0.014	0.035
Dry leaf at 60°C	0.962	0.011	0.035
S.Em.±	0.088	0.001	0.002
C.D. at 5%	0.203	0.002	NS
C.V.%	9.355	7.593	8.031

Table 4. Effect of temperature and embedding media on leaf colour of asparagus.

Treatments	4^{th} h	8^{th} h	12^{th} h	16^{th} h
T_1M_1	A	A	A	B
T_1M_2	A	A	B	B
T_1M_3	A	A	B	B
T_1M_4	A	A	B	C
T_2M_1	A	A	A	B
T_2M_2	A	A	B	B
T_2M_3	A	A	C	C
T_2M_4	A	A	B	B
T_3M_1	A	A	B	B
T_3M_2	A	A	B	C
T_3M_3	A	B	C	C
T_3M_4	A	A	B	B

Where, A – Bright, B - Dull effect, C - More dull effect.

shrinkage of cell, resulting in greater reduction in leaf size.

Effect on pigment content

The data clearly showed (Table 3) the reduced pigment content after drying. Oven drying at 50°C showed significantly maximum chlorophyll and carotene content 1.230 and 0.017 mg/g tissue respectively. Whereas, xanthophyll was found to be non significant. Higher reduction in pigments at higher temperature was observed. Similar results of higher degradation of chlorophylls at higher temperature have also been reported by Possingham et al. (1980) in Chines gooseberries, Fedorenko and Fedorenko (1987) in forage crops and grass mixture, Levin (1989) in conifer foliage and Gusakova and Khomova (1998) in *Ziziphora pedicculata*. Enhanced carotenoid reduction with increase in temperature was also reported by Livingston et al. (1979) in alfalfa grass, Pulkinen (1979) in Lucern, Ramos and Rodriguez (1993) in spinach, Minquez et al. (1994) *in Capsicum annum,* Singh et al. (2002) in zinnia, Pandya and Saxena (2001) and Dahiya et al. (2003) in chrysanthemum flowers.

Effect on leaf colour

The leaf dried with different treatment was visually examined and the effect on leaf colour was recorded. Oven drying with sand at 50°C (T_1M_1) and 55°C (T_2M_1) showed for bright colour on 4, 8 and 12^{th} h of oven drying. Oven drying at 55°C with borax (T_2M_3) and 60°C with borax (T_3M_3) showed more dull leaf colour on 12^{th} and 16^{th} h. (Table 4).

Drying at high temperature the colour of leaf normal to more dull. Colour of leaf was influenced by degradation of pigments as well as auto oxidation of carotenoids. This was resulted into change in colour of leaf after drying. Media also influenced leaf colour, where bleaching property of borax resulted into fading effect while no such effect was observed with sand and silica gel. This browning effect of yellow colour may have provided darker colour. Sanders et al. (1989) also reported increased colour intensity in pea nut curing at higher temperature. Sharma et al. (2000) explained that carotenoids are highly susceptible to auto oxidative degradation during processing and storage of products that causes discolorration.

Effect on leaf surface

Leafs dried with Sand: Borax (1:1) and borax at 50°C temperature (T_1M_2), (T_1M_3), 55°C temperature (T_2M_2), (T_2M_3) and 60°C temperature (T_3M_2), (T_3M_3) showed smooth textured petals till 12^{th} h of oven drying. Whereas, silica gel 60°C temperature (T_3M_4) exhibited highly rough petal texture on 12^{th} and 16^{th} h of oven drying (Table 5).

During initial stage of drying the surface of leaf was not much affected by drying temperature and embedding media, and it was smooth in all treatments as drying proceeded, both temperature and embedding media influenced leaf surface. High temperature and silica gel exhibited rough surface in dried leaf than low temperature with borax drying. This may be attributed due to unevenness in the cell layer on shrinking due to excessive and rapid loss of moisture after specific drying. While low temperature with borax exhibited equal pressure to leaf and also absorbed moisture more evenly form the leaf

Table 5. Effect of temperature and embedding media on leaf surface of asparagus.

Treatments	4^{th} h	8^{th} h	12^{th} h	16^{th} h
T_1M_1	+	+	++	++
T_1M_2	+	+	+	++
T_1M_3	+	+	+	++
T_1M_4	+	+	++	+++
T_2M_1	+	+	++	++
T_2M_2	+	+	+	++
T_2M_3	+	+	+	++
T_2M_4	+	+	++	+++
T_3M_1	+	+	++	++
T_3M_2	+	+	+	++
T_3M_3	+	+	+	++
T_3M_4	+	++	+++	+++

Where, + - Smooth ++ - Slightly rough +++ - Highly rough.

Table 6. Mechanical damage observed in asparagus leaf during oven drying.

Treatments	4^{th} h	8^{th} h	12^{th} h	16^{th} h
T_1M_1	*	*	*	**
T_1M_2	*	*	*	**
T_1M_3	*	*	*	**
T_1M_4	*	*	**	***
T_2M_1	*	*	**	**
T_2M_2	*	*	*	**
T_2M_3	*	*	*	**
T_2M_4	*	*	**	***
T_3M_1	*	*	**	**
T_3M_2	*	*	**	**
T_3M_3	*	*	*	**
T_3M_4	*	*	**	***

Where, * No damage ** 0 - 10% damage *** 10 - 20% damage.

leaf tissue. Thus, drying rate going higher at 60°C with silica gel (T_3M_4) than 50°C with borax (T_1M_3), so it showed roughness in texture. This finding was in conformity with Alka Singh et al. (2004) in zinnia flower, Deshraj and Gupta (2005) in various herbaceous foliage.

Mechanical damage observed

In all treatments, no mechanical damage was observed up to 8^{th} h of oven drying. Least mechanical damage was observed in the leaf dried at 50°C temperature with sand (T_1M_1), sand: borax (1:1) (T_1M_2), borax (T_1M_3) treatment combinations, 55°C temperature with sand: borax (1:1) (T_2M_2), borax (T_2M_3) and 60°C temperature with borax (T_3M_3). While maximum mechanical damage was noticed on 16^{th} h in the leaf dried with 50, 55 and 60°C temperature with silica gel (T_1M_4, T_2M_4 and T_3M_4) (Table 6). This may be due to rupturing of cells because of rapid moisture loss of flower and foliage and resulted in shedding of cladodes. Also, abscission of leaves is catalysed at higher temperature. Over drying due to higher temperature in silica gel made foliage brittle and breaking of petals and leaflets occurred. Similar findings that quality of onion also degraded at higher temperature were reported by Singh and Singh (2000).

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