Effect of post-harvest ripening and drying methods on seed quality and storability in pumpkin cv Pusa Hybrid 1

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Received: 16 April 2014; Revised accepted: 30 July 2014

ABSTRACT

An investigation was carried out, to study the effect of post-harvest ripening and drying methods on the seed quality in pumpkin cv Pusa Hybrid 1, during summer 2008 and 2009 at Seed Production Unit, IARI, New Delhi. After harvesting, the fruits were allowed for post-harvest ripening (PHR) of zero days (P0), 10 days (P1) and 20 days (P2) and seeds obtained from each of the PHR treatments were subjected to three methods of drying, viz. shade drying (D1), sun drying (D2) and mechanical drying (D3). The results showed that seed obtained from 20 days PHR followed by shade drying (P2D1) had given superior quality seed with respect to germination (94.33 %), seedling length (34.30 cm), vigour index - I (3236.52) and electrical conductivity (17.30 mHs/cm/g) followed by P2D3 (20 days PHR and mechanical drying), while germination (%) was significantly lower in PoD2 during storage. In all treatments the seeds stored for 12 months showed maximum germination followed by reduction after eighteen months of storage. The germination percentage was maintained above the Indian minimum seed certification standards (IMSCS) of 60% up to eighteen months of storage in all treatments.

Key words: Drying method, Post-harvest ripening (PHR), Mechanical drying, Seed quality, Shade drying and Sun drying,

Pumpkin occupies a prominent place among vegetables owing to its high productivity, nutritive value, good storability thereby better transport potentialities. It is extensively grown during rainy and summer months in all parts of India.

Pumpkin fruit is commonly used as a vegetable both at immature and mature stage. The yellow and orange fleshed fruits are very rich in carotene (3332 IU), with fair quantities of vitamins B and C (Premnath et al. 1973). Pumpkin seeds are also a rich source of carbohydrates (22%), proteins (30%), oils (40-50%), minerals and vitamins (Singh 1998). India is the second largest producer of pumpkin in the world after China. Pumpkin, squash and gourd are grown in India over an area of 0.51 million ha with the production of 4.90 million tonnes (FAO 2012). The average productivity of pumpkin, squashes and gourds is 9.60 tonnes/ha in India, which is lower than the world’s average productivity of 13.41 tonnes/ha. The higher productivity in Israel and Netherlands is due to the coverage of maximum area under hybrids whereas lower productivity in India is due to occupation of major area by open pollinated varieties (OPV). The pumpkins are being cultivated by resource poor farmers who cannot afford high cost of hybrid seed. The quality of seed largely depends on the stage of harvest.
development of micro-organisms (Christensen and Kaufman 1965). Therefore, an attempt was made to find out the suitable period of PHR and practicable drying method to maintain high seed viability and vigour during storage in pumpkin.

MATERIALS AND METHODS

An experiment was conducted during summer season of 2008 and 2009 at Seed Production Unit (SPU), Division of Seed Science and Technology (DSST), Indian Agricultural Research Institute (IARI), New Delhi. The seed of parental lines of Pusa Hybrid 1 obtained from the Division of Vegetable Science, IARI, New Delhi were grown by adapting the good agricultural package of practices (GAP). The crossed fruits were obtained by following the hand pollination method (Vishwanath 2007). The crossed fruits harvested at vine drying stage were allowed for three different post-harvest ripening (PHR) period’s, viz. zero days PHR (P0), 10 days PHR (P1), 20 PHR (P2). Seed obtained from each of them were having initial moisture content around 30-40% so these seeds were subjected to three different drying methods, viz. shade drying (D1), sun drying (D2) and mechanical drying (D3) at 35°C temperature. The seeds were dried under shade (D1) and direct sun light (D2), every day from 9.00 am to 5.00 pm for 5-7 days till the seed attained 8-9 per cent moisture content. In mechanical drying, the seeds were dried in a mechanical seed drier at a constant temperature of 35°C for 5 hr. After drying seeds were packed in polythene bag (500 gauge) and stored under ambient conditions (28°C ± 3°C temperature, 70% ± 5% RH). The seed quality attributes such as germination (%), seedling length (cm), seedling dry weight (mg), vigour index – I, vigour index – II, moisture content (%) were conducted by adopting the ISTA procedure (Anon 2008) and electrical conductivity (µ mhos/cm/g) of seed leachate was determined as per the procedure of Dadlani and Agrawal (1987). The seed storability was studied by conducting germination test at 3 months interval regularly up to 18 months. The data was statistically analyzed by following Randomized Complete Block (RCB) design in factorial concept using SAS statistical package version 9.2.

RESULTS AND DISCUSSION

Germination (%)

The results on the effect of post-harvest ripening and drying method and their interaction on germination (%) were presented in Table 1. Post-harvest ripening significantly influenced the germination %. Seed obtained from P2 showed significantly higher germination (90.81%) followed by P1 (90.67%). The lowest germination was recorded in P0 (88.56%).

Among the different methods of seed drying, (D1) recorded higher germination (93.44%) followed by D3 (91.44%), while the lowest value was noticed in D2 (87.56%). The interaction effect due to post harvest ripening and drying method also significantly influenced the germination (%). The higher germination (%) was recorded in P2D1 (94.33%) followed by P2D3 (93.33%) and P1D1 (93.33%) with lowest recording in P0D2 (83.67%).

Seedling length (cm)

The marked differences on seedling length were observed for post harvest ripening and drying methods and their interaction (Table 1). The results revealed that seedling length was significantly higher in P2 (33.34 cm) than in P1 (32.51 cm) and P0 (30.78 cm) irrespective of drying methods. Significant differences due to drying methods were noticed for seedling length. It was significantly maximum in D1 (33.34 cm) followed by D3 (32.03 cm) whereas D2 recorded significantly minimum seedling length

Table 1 Effect of post-harvest ripening and drying methods in seed quality of pumpkin cv Pusa Hybrid 1

<table>
<thead>
<tr>
<th>Post-harvest ripening</th>
<th>Drying methods</th>
<th>Germination (%)</th>
<th>Seedling length (cm)</th>
<th>Seedling dry weight (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D1 D2 D3 Mean</td>
<td>D1 D2 D3 Mean</td>
<td>D1 D2 D3 Mean</td>
<td>D1 D2 D3 Mean</td>
</tr>
<tr>
<td>P0 92.67 83.67 89.33 88.56</td>
<td>32.07 29.48 30.79 30.78</td>
<td>43.03 46.69 50.18 46.63</td>
<td></td>
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<tr>
<td>(74.46) (66.53) (71.09) (70.70)</td>
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</tr>
<tr>
<td>P1 93.33 87.00 91.67 90.67</td>
<td>33.64 31.70 32.18 32.51</td>
<td>47.58 50.27 52.24 50.03</td>
<td></td>
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<tr>
<td>(75.32) (69.11) (73.38) (72.60)</td>
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</tr>
<tr>
<td>P2 94.33 92.00 93.33 90.81</td>
<td>34.30 32.59 33.13 33.34</td>
<td>48.13 51.93 54.75 51.60</td>
<td></td>
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<tr>
<td>(76.62) (74.00) (75.93) (75.52)</td>
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<tr>
<td>Mean 93.44 87.56 91.44 93.63</td>
<td>33.34 31.26 32.03 32.21</td>
<td>46.25 49.63 52.39 49.42</td>
<td></td>
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<tr>
<td>(75.47) (69.88) (73.47) (72.94)</td>
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</table>

*Transformed (arc sin) value in parenthesis. P0 - zero days Post-Harvest Ripening, P1 - 10 Days Post-Harvest Ripening, P2 - 20 Days Post-Harvest Ripening, D1 - Shade drying, D2 - Sun drying, D3 - Mechanical drying, HSD – Tukey’s Honest Significant Difference, NS – Non Significance
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(31.26 cm). Non-significant differences were observed for 
P × D interaction effect. However, more seedling length 
was noticed in P2D1 (34.30 cm) followed by P1D1 (33.64 
and lowest in P0D2 (29.48 cm) treatment combination.

Seedling dry weight (mg)

Significant variations on seedling dry weight due to 
post harvesting ripening and drying methods were observed 
with their interaction effect (Table 1). The results showed 
that, the P2 recorded significantly highest seedling dry weight 
(51.60 mg), followed by P1 (50.03 mg). The lowest seedling 
dry weight was observed in P0 (46.63 mg).  The mechanical 
drying method (D3) recorded significantly maximum 
seedling dry weight (52.39 mg) as compared to other 
methods irrespective of post harvesting ripening followed 
by D2 (49.63 mg) and minimum was in D1 (46.25 mg).

Interaction effect of post-harvest ripening and drying 
methods (P × D) was found non-significant for seedling dry 
weight with numerically higher seedling dry weight in P2D3 
(54.75 mg) and lower in P0D1 (43.03 mg).

Vigour index - I

The highest and lowest vigour index - I was noticed in 
P2 (3109.19) and P0 (2728.04), respectively over drying 
methods and the highest vigour index was recorded in D1 
(3116.76), followed by D2 (2910.73) and lowest in D3 
(2759.12) over post harvesting ripening (Table 2). The significant differences were also observed for 
P × D interaction effect. Highest vigour index was noticed in 
P2D1 (3236.52), followed by P1D3 (3092.94) and lowest in 
P2D2 (2521.07).

Vigour index – II

The seeds obtained from P2 recorded significantly higher vigour index - II (4810.81) while, P0 recorded lower value (4123.12). Drying methods produced significant effect on vigour index – II and found that mechanical drying(D3) recorded significantly maximum vigour index – II (4793.72), while, it was minimum (4324.10) in shade drying (D1) (Table 2). The interaction effect due to post harvest ripening, 
drying methods showed non-significant differences in vigour index - II.

Electrical conductivity (µ mhos/cm/g)

The results showed that P0 and P2 recorded significantly higher (34.21) and lower (21.46) electrical conductivity irrespective of seed drying methods. The sun drying (D2) recorded significantly highest electrical conductivity (32.97) of seed leachates while lowest electrical conductivity (25.46) was observed in D1 irrespective of post harvesting ripening (Table 2).

Storability

The results revealed that germination percentage due 
to interaction between post-harvest ripening and drying 
methods differed significantly with the mean values of 
26.67%, 83.48%, 87.63%, 90.15%, 91.63%, and 87.48% at 
zero, three, six, nine, twelve and eighteen months of storage 
period (Table 3). Germination percentage was found to 
increase with the advancement of storage period from zero 
(26.67%) to twelve months (91.63%) followed by reduction 
at eighteen months (87.48%) among all treatments.  The 
initial germination (%) ranged from 11.00% in P0D2 to 
48.33% in P2D1 at the beginning of storage period. The seed 
of all treatments after three months of storage showed sharp 
increase in germination percentage (83.48%) thereafter the 
increase was gradual.

Germination percentage was significantly higher 
(48.33%, 89.67 %, 92.67 %, 95.83 % and 97.00 % ) in the seeds of P2D1, while it was significantly lower (11.00 %, 
78.00 %, 82.67 %, 85 % and 87.67 % ) in seeds of P2D1 at 
zero, third, sixth, ninth and twelth months of storage period, 
respectively. P2D1(92.33%) and P2D3 (93.00%) were at par 
with regard to germination percentage after eighteen months 
of storage period though marginally higher values were 
recorded in P2D3. The results revealed that the rate of 
reduction in germination percentage was slower in 
mechanical drying than in shade drying after eighteen
months of storage. This was visible in P2D1 and P2D3, where the germination (%) declined from 97.00% at twelve months of storage to 92.33% at eighteen months in P2D3 with a reduction of 4.67%, whereas in P2D2, the germination fell from 93.67 to 93.00% with the decline of just 0.67%. The germination percentage above the minimum seed certification standards (IMSCS) of 60% were maintained up to eighteen months of storage in all treatment combinations.

Post-harvest ripening showed significant effect on seed quality. The highest germination (90.81%), seedling length (33.34 cm), seedling dry weight (51.60 mg), vigour index – I (3109.19) and vigour index – II (4810.81) were observed in P2D1 and it could be attributed to continued development of immature and matured embryos to attain physiological maturity of seed during post-harvest ripening which was evident by lower electrical conductivity of seed leachate (21.46 μmhos/cm/g). The higher germination percentage in P2 could be attributed to the increased growth potential of the embryo during post-harvest ripening, which enhanced the capability of radical to penetrate seed coat which is a physical barrier in seeds (Weston et al. 1992). Similar findings were reported in other cucurbits such as water melon (Alvarenga et al. 1984), cucumber (Barbedo et al. 1993, Nandeesh et al. 1995) as well as in non-cucurbits, viz. Indian chilli (Pandita and Nagarajan, 2001) and tomato (Dias et al. 2006).

The methods of drying had significant influence on seed quality parameters like seed germination, seedling length, seedling dry weight, vigour index - I, vigour index – II and electrical conductivity. Among, the three drying methods, shade drying of seeds (D1) recorded significantly superior performance due to the possible minimum moisture stress effect owing to slow drying under constant temperature without exposure to continuous UV radiation effects. The high temperature in mechanical drying resulted in rapid loss of moisture thus inducing a severe moisture stress on embryo affecting the seed performance. The poor seed quality in sun drying could be due to direct exposure of seed to high energy ultra violet radiation (UV rays) associated with faster rate of desiccation and seed deterioration (Harrington 1960, Singh and Ojha 1972). These results are in agreement with the findings of Javaregowda et al. (1994) in brinjal, Nascimento et al. (1994); Suryawanshi et al. (1996), Ravi kumar (2005) in cucumber, Nepane et al. (1993) in sweet pepper and Shantappa et al. (2006) in bitter gourd.

Post-harvest ripening and drying method interaction differed significantly with respect to germination and vigour index – I. Maximum germination and vigour index – I were recorded in P2D1 and it could be attributed to continued development of embryo with in seed during PHR and constant drying temperature during drying period resulting in better seed quality.

Good seed storage is a basic requirement in any seed production programme. The longevity of seed predominantly depends on the moisture content of seeds, temperature and RH of storage. Cucurbits, in general, have storability of 3 to 4 years and grouped under good storer. Under ambient conditions (28°C ± 3°C temperature, 70% ± 5% RH) in Delhi, the seeds of P0D1 showed significantly higher values of germination percentage compared to other treatment combinations up to twelve months of storage period. This superiority in P0D1 could be attributed to fully developed and vigorous embryo and the favourable effect of shade drying on seed quality in terms of germination. Similar findings were also reported in ash gourd (Ganar et al. 2004). The slower rate of reduction in germination percentage after eighteen months of storage in P0D1 is owed to the low moisture content in seeds.

CONCLUSION

It is concluded that the harvested fruits of pumpkin should be allowed for 20 days of post-harvest ripening before seed extraction and seeds should be dried under shade for getting higher seed quality.
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