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The Effect of Different Drying Processes on the Quality of Pepper Seeds Harvested in Uşak Conditions

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Abstract

It stated that drying can delay post-harvest metabolic and physiological processes that contribute to the deterioration of seed quality with storage processes. Generally, as a dryer; silica gel, activated charcoal, bentonite, calcium sulfate, calcium chloride, and zeolite are used. The aim of our study was to determine that different drying methods (FD (frist drying)-SD (second drying)) and post-harvest ripening processes were harvested in Uşak conditions in 3 different maturation periods in the first year after flowering and in 4 different maturation periods in the second year and the change in the viability of pepper seeds. At the end of the applications, parameters such as germination and seedling emergence rate test, and seedling fresh and dry weight and enzyme activity were examined. While pepper seed germination values were tested, the drying and drying+ripening treatments applied to the seed lots that were immature had a positive effect on the results. CAT activity in pepper results, C (control), and PHR (post-harvest ripening) in 60th-day seeds; SOD activity is SD in the first year, C in the second year; APX was found to be high in C and PHR applications. In general, drying and drying+ripening processes according to the harvest periods were found to be advantageous in pepper species.

Key words

Pepper, drying, postharvest ripening, enzyme activity, seed viability.

Introduction

The production of seedlings and seeds should be given priority when thinking about vegetable production. The adequacy of environmental elements must be considered when selecting a seed-producing place. Seed development in production is affected by genetic, physiological, and environmental conditions. For this reason, seed development periods can be different even in plants grown under the same environmental conditions. Conditions of the seed before and after harvest affect the viability and quality of the seed (Demir and Balkaya, 2005). It is important to know the appropriate time for a quality seed harvest (Toole et al., 1956). Two important maturity concepts emerge with seed maturity; physiological and harvest maturity. Determination of the most appropriate harvest time is of great importance since physiological maturity is associated with the maximum accumulation of dry matter transported to the seed. Harvest maturity is the developmental period when the seed becomes suitable for storage. Seed drying processes can be performed in different ways. These drying methods can be listed as a dry room or drying room, desiccants (Silica gel/charcoal), saturated salts/lithium chloride solutions, air-conditioned rooms/vehicles, and incubator dryers. A desiccant is a hygroscopic substance that causes or maintains a desiccant state in its environment. The most common desiccant is silica, and other common desiccants are activated charcoal, bentonite, calcium sulfate, calcium chloride, and zeolites (Ashok et al., 2017). Post-harvest seed drying can be done in different ways. In some crops, the seeds dry out heavily on the mother plant. The seeds can be dried with non-pressurized air, compressed air, or heated (25 °C) compressed air. Products, particularly agricultural ones, are typically dried with warm air. According to studies, immature or even less mature seeds should not be dried quickly in order to produce seeds that will survive for a long time. In addition, it can be determined by tests that drying immature seeds with heated air, as is done in some agricultural products, causes a further decrease in seed life and seed viability (Groot and Groot, 2008). Fruit harvesting stages and the time after they completed ripening had a big impact on how seeds developed and what kinds of yields they produced. The post-harvest ripening stage of seeds offers the possibility of an early harvest of fruits with improved quality and quantity. Additionally, it extends the maturation time of the seeds, improving vigor and germination. Combining these changes showed that seeds were healthy in terms of their physical and physiological conditions during PHR. Additionally, PHR promotes the development of the immature seed inside the fruit and prevents drying-related damage to the cell membrane integrity, which reduces the production of ROS and, as a result, the antioxidant activity (Gill and Tuteja, 2010). One of the key antioxidant enzymes is SOD, which breaks down the superoxide anion (O_2) into H_2O_2 and oxygen before being detoxified by CAT and POX.

In our study, the effects of post-harvest ripening and drying at different speeds on the physiological quality of seeds of pepper species harvested at different maturity periods were investigated.

Materials and Method

The study was carried out in the application field and research laboratory of the Faculty of Agriculture of Uşak University. Pepper (*Capsicum annuum* L.) seed lots of Burdem cultivar, belonging to 3 (40, 50, 60) maturation periods in the first year and 4 (40, 50,60,70) maturation periods in the second year, were used (Fig. 1). It was tried to determine the effect of storage after two different drying applications on seed viability, vigor, and enzyme activation in seeds obtained from fruits harvested at different periods after flowering. The parameters determined as a result of these tests; were moisture content, germination rate (%), seedling emergence rate (%), seedling fresh-dry weight (gr), SOD, APX, and CAT enzyme activities at 25 °C.

Fig 1. Images of peppers harvested at different times (left to the right: 40-50-60-70. DAA)

Table 1. 2018 meteorological data of the location of the application land

Meteorological data (month)	January	February	March	April	May	June	July	August	September	October	November	December
Total precipitation (mm= kg/m^2)	62.1	59.0	56.6	7.9	76.7	48.1	21.0	43.3	0.1	53.8	63.4	92.9
Mean temperature °C	3.6	6.7	9.3	15.3	17.2	20.2	23.7	24.3	20.7	4.9	9.6	3.7
Mean relative humidity %	73.3	73.9	67.9	47.8	61.2	59.3	49.1	48.3	45.6	59.0	67.3	80.3

Table 2. 2019 meteorological data of the location of the application land

Meteorological data (month)	January	February	March	April	May	June	July	August	September	October	November	December
Total precipitation (mm= kg/m^2)	78.8	13.7	14.8	28.8	32.5	36.6	9.3	3.9	29.1	-	-	-
Mean temperature °C	2.8	5.4	7.8	10.4	16.7	20.9	22.8	24.4	19.8	19.0	-	-
Mean relative humidity %	80.5	65.9	58,5	60,6	55,5	58,6	47.1	42.7	51.6	48.2	-	-

Table 3. Application field soil analysis result

	pH	Salt (2micros/cm)	Lime (%)	Organic matter (%)	Saturation (ml)	Total N (%)	Useable P (ppm)	Useable K (ppm)
0-30 cm	7.70	1059	9.1	0.84	65	0.042	0.56	250
Evaluation	Slightly Alkaline	Lightly salted	Medium chalky	Slightly	Clay loam	Poor	Very poor	Sufficiently
Activated lime	0-30	-	-	-	-	-	-	-

Determination of initial moisture content of seed lots

Seed moisture content (%) was determined using the high-temperature oven method (ISTA, 2003) on two replicates of 1 g seeds held at 130 °C for 1 hour. The samples were then allowed to cool for half an hour in a desiccator. Moisture content is expressed on a fresh weight basis.

Seed drying processes

Two different drying processes were carried out in the study. In the first drying (FD), which was continued for five days, the seeds were dried in a saturated solution of CaCl2 in a 35°C incubator for the first three days, and in the air (at ambient conditions) without any saturated salt solution in a 35°C incubator on the fourth and fifth days. In the second drying application (SD), KNO_3 (90.79±0.83% RH) on the first day, NaCl (74.87±0.12% RH) on the second day, CaCl (≅45% RH on the third day) in 35°C incubators) on the saturated solutions, on the fourth and fifth days, it was air-dried in a 35°C incubator without any saturated salt solution.

Post-harvest ripening application

In the study, the control group (C), first drying (FD) and second drying (SD) processes of the pepper seeds harvested at different harvest periods were applied, as well as the control group, at 35 °C and in hermetic packages (PHR, FD+PHR, SD+PHR) post-harvest ripening process was applied. As a result of this process, seed viability, germination, seedling emergence, and enzyme activity test.

Determination of seed viability

a. Germination test (%)

The paper-to-paper method was used to test the germination of 50 seeds in 4 replications for each lot at a temperature of 25 ºC (ISTA, 2005). At the end of the germination test, normal and abnormal seedlings (%) were determined. The emergence time was calculated using the formula using daily counts during germination (Demir and Güney, 1994).

b.Seedling emergence test (%)

4x50 seeds were sown in peat medium for 21 days at 25°C in 16 hours of light and 8 hours of darkness. A daily emergence count was performed and mean emergence time was calculated (Demir and Güney, 1994). At the end of the emergence experiment, the seedlings were distinguished as normal/abnormal (ISTA, 2003), and the number of normal ones was given as %.

c. Determination of Seedling Fresh and Dry Weight

As a result of the seedling emergence tests, 5 seedlings were randomly selected from each replication and their wet weight was determined and their dry weight (g/plant) was determined by drying at 80°C for 1 day.

d. Enzyme Activation in Seed

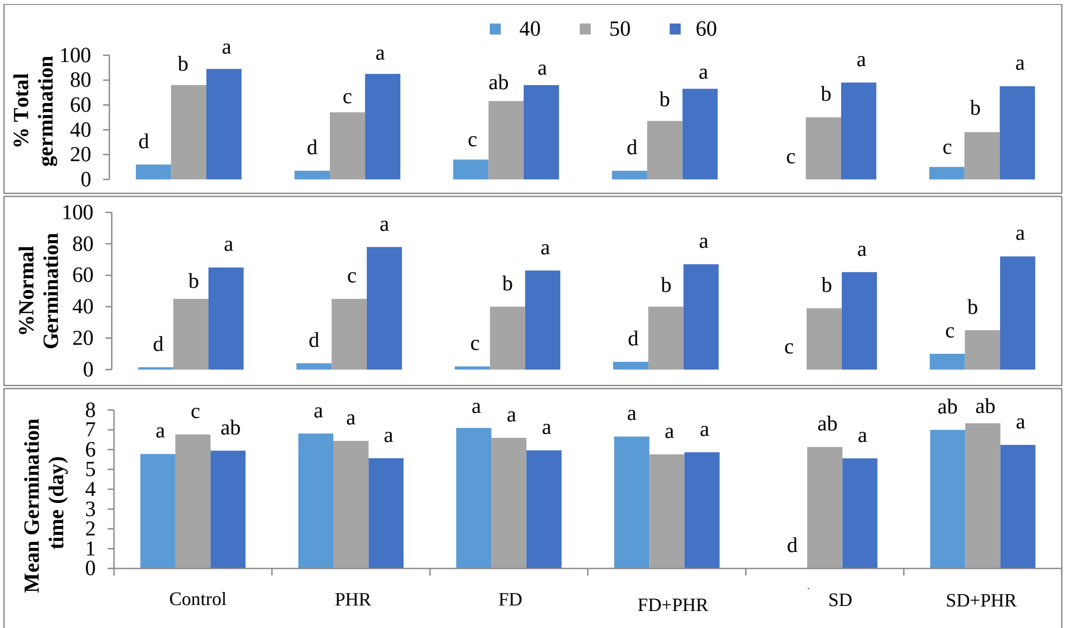
In order to determine the change in the SOD, CAT, and APX enzyme activities of the pepper (50-60) seed harvested at different harvest periods and all the applications applied to these seeds, 0.5 g of seed sample was crushed in liquid nitrogen in porcelain mortars in each replication. It was homogenized with 5 ml of cold (0.1 M Na-phosphate pH 7.5), 0.5 mMNa-EDTA, and 1 mM Ascorbic acid. After the homogenized samples were centrifuged at 18000 rpm for 30 minutes at 4 °C, the obtained samples were kept at room temperature for 1 hour (Jebara et al.,2005; Sairam and Saxena 2000).

Statistical analysis (Duncan) was performed using SPSS 23 to perform ANOVA analyses. The comparison of the averages was made at the 5% level.

Results and Discussion

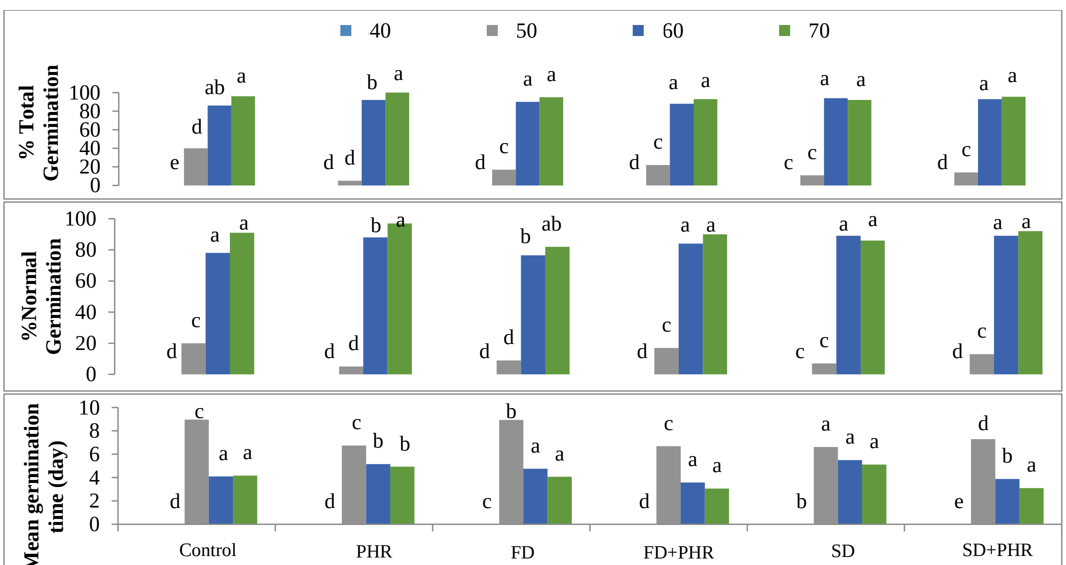
Germination Test Results of Pepper Seeds Harvested at Different Maturity Periods as a Result of Drying and Post-Harvest Ripening Applications (%)

25°C germination test of seeds belonging to control (C), post-harvest ripening (PHR), first and second drying method (FD, SD) and combination applications of seed lots of Burdem variety harvested at different maturity (40, 50, 60 and 70th days) periods and results (TG, NG, MGT) are given in figure 2. In the results of the germination test performed at 25°C in the 1st year results, the highest germination values were determined in the 40th day seeds with 16% in the FD group, in the 50th day harvest with 76%, and in the 60th day with 89% in the C group. Normal germination values were determined in the 40th day seeds with the highest 10% in SD+PHR, in the 50th day harvest with 45% K and PHR, and in the 60th day harvest with 78% in PHR applications. When the harvest days are considered on the basis of statistically obtained parameters, TG and NG values were found to be significant at the 1% level, while the MGT value was not significant (p>0,05). However, the parameters were not found significant in terms of drying applications (p<0,01)(Fig 2). Alan and Eser (2007), in their study in which they examined the relationship between fruit location on the mother plant and seed quality; mean germination time (at 15 and 25°C) was significantly affected by fruit position with harvest in 2004, while differences were not statistically significant in 2005. In our study, statistically similar results were obtained in terms of MGT, although seed harvests were carried out regardless of the stage. In our first production year, drying applications in pepper seed lots (40th and 50th days) showed lower germination performance than the control group. According to Herter and Burris (1989), some studies have been conducted on the effect of drying damage on seed germination. For example, Navratil and Burris (1984) reported that drying damage affects root growth more than shoot growth. There have been numerous studies on how changes in the seed during drying might impair germination and reduce quality, including enzyme and protein denaturation, reduced starch grain size, membrane degradation, seed coat cracking, and other issues.



Harvestday*PHR*drying p>0.05, harvestday*drying: p>0.05, P values show the significance of the interaction between Harvestday and applications. The means shown with different letters within the same application are statistically significant at the level of the specified P value.

Fig 2 Germination test results of pepper seeds of different maturity at 25 °C between paper (%)(1st year)



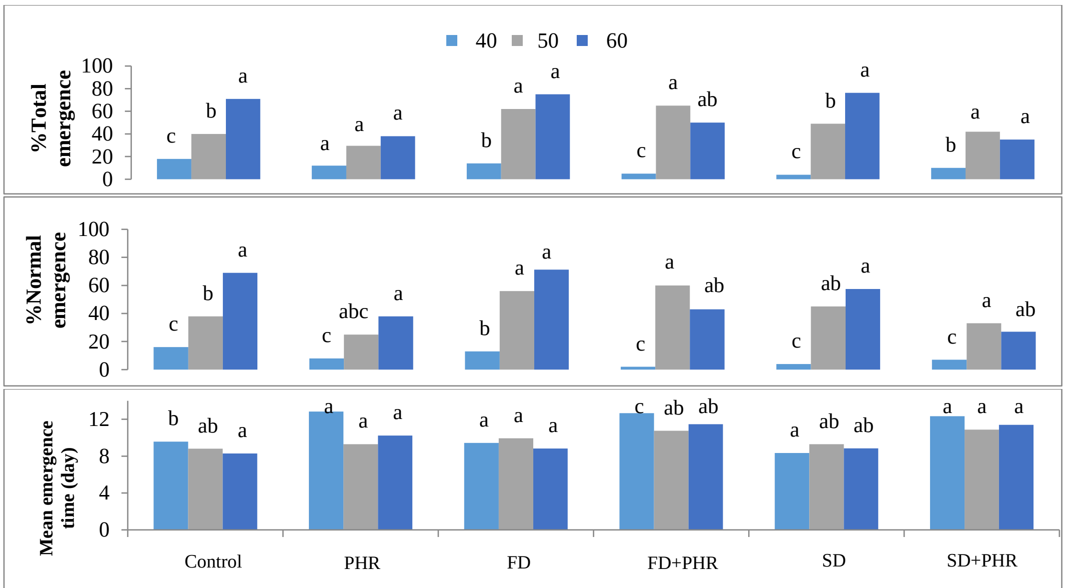
Harvestday*PHR*drying, harvestday*drying: p>0.05, P values show the significance of the interaction between harvest day and applications. The averages shown with different letters within the same application are statistically significant at the level of the specified P value.

Fig 3. Germination test results of pepper seeds of different maturity at 25 °C between papers (%) (2nd year)

While there was no germination in the seeds of the 40th day in the germination test performed at 25 °C in the 2nd year, the total germination values of the seeds of the other harvest days were 40% C, in the 50th day seeds, 94% SD in the 60th day seeds, and 100% in the 70th day seeds. The PHR group gave the highest total germination percentage. The highest normal germination percentages were determined in the 50th day seeds with 20% C, 89% SD and SD+PHR in the 60th day seeds, and 97% PHR in the 70th day seeds. The earliest germination in the MGT data was determined in the groups (3.1 days) of the 70th day harvested seeds that were subjected to FD+PHR and SD+PHR treatments. When the harvest days are considered on the basis of the statistically obtained parameters, TG, NG and MGT values were found to be significant at the 1% level, while the parameters were not significant in terms of drying applications ($p<0,01$)(Fig 3.). Vigidal et al.(2011), in a similar study on pepper seeds, stated that seed viability increased during the ripening process, although there were small differences between the strength tests regarding the harvest time when the seed vigor was maximum. Overall, maximum seed viability was recorded after about 60 anthesis when the fruits were red. Maximum seed quality can be determined by a combination of characteristics such as germination percentage and vigor. In general, the greatest dry matter content reached at day 75 after anthesis, and this was attained at about day 75 after anthesis, when the fruit has a red color on the outside, similar to mass maturity, is connected with the maximum germination and viability of sweet pepper seeds. Similar to our seed maturity processes (especially with SD and FD treatments), a high seed germination percentage was obtained, which slowly increased from day 50 to day 70 after anthesis.

Seedling Emergence Test Results with Drying and Post-Harvest Ripening Applications of Pepper Seeds Harvested at Different Maturity Periods (%)

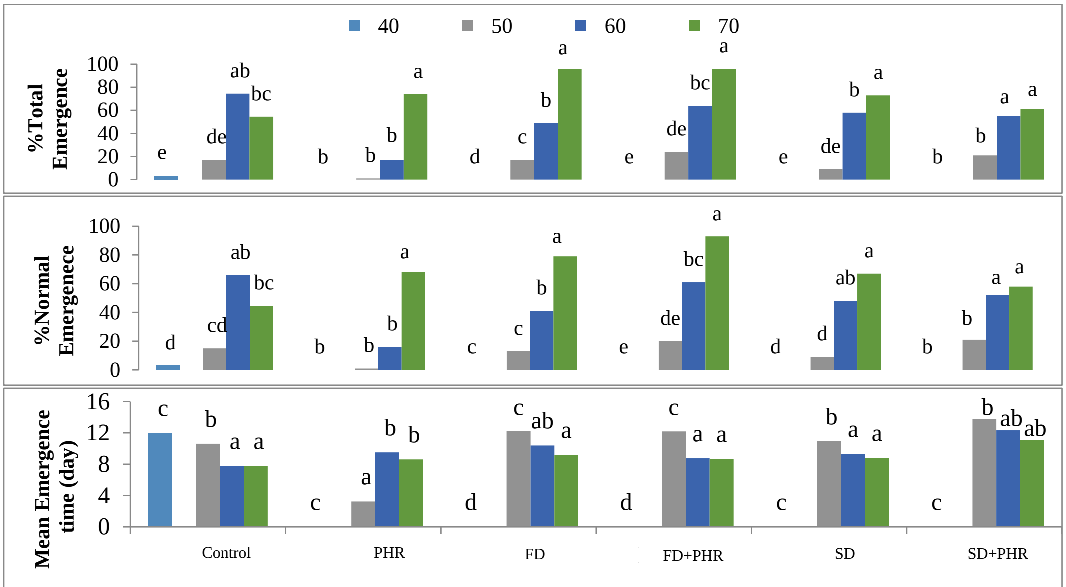
25℃ emergence test results (TE, NE, MET) of control (C), frist and second drying method (FD, SD) and combination applications of seed lots of Burdem variety harvested at different maturity (40, 50, 60 and 70th days periods) are given in figure 3. In the results of the first year at 25℃, the total emergence values were determined as 18% in the 40th day seeds, 65% in the 50th day harvest with FD+PHR, and 76.3% in the 60th day harvest. Normal emergence values were determined in the 40th day seeds with 16%, the highest in the 50th day harvest with 60% FD+PHR, and in the 60th day harvest with 71,3% in the FD applications. In terms of MET data, no significant difference was observed in all maturity and applications, and the earliest germination was determined in the C treated group (8.3 days) of the 60th day harvest. The statistically determined parameters were not found to be significant when the harvest dates and drying procedures were considered ($p>0,05$) (Fig 4.). Oliveira et al. (1999), in a study they conducted with pepper seeds (*Capsicum annuum* L.), found high values for germination and viability of seeds extracted from old fruits harvested starting from the 55th day after anthesis, and the highest values were found in fruits harvested between 60 and 70 days after anthesis. quality was found. In pepper seed lots with different maturity, 60th day harvests gave the best results with FD and SD applications.



Harvestday*PHR*drying: $p>0.05$, harvestday*drying: $p>0.05$, P values show the significance of the interaction between Harvestday and applications. Averages shown with different letters within the same application are statistically significant at the level of the specified P value.

Fig 4. Evaluation of pepper seeds of different maturity by 25℃ seedling emergence test(%)(2018)

In the results of the emergence test carried out at 25℃ in the 2nd year, while it was between 0-3% for the seeds on the 40th day, the highest values for the total emergence were FD+PHR for the 50th (24%) day seeds, and C for the 60th (74.5%) day seeds, FD and FD+PHR groups showed 96% on the 70th day seeds. While normal emergence values are between 0-3% in 40th day seeds, the highest values are SD+PHR with 21% in 50th day harvest, 70th day(93%) seeds and 60th (%) seeds. 66) day (87.5) showed group C in seeds. There was no significant difference in all maturity and applications in terms of MET data, and the earliest germination was determined in the C group (3.3 days) of the 50th day harvest. Considering the harvest days on the basis of statistically obtained parameters; In terms of TE, NE values and drying applications, only MET was found to be significant at the 1% level ($p<0,01$)(Fig 5.). Bektaş (2003) investigated the effects of different drying temperatures and harvesting periods on seed quality in seeds taken from the fruits of Sera-Demre 8 pepper variety harvested in different periods. The fruits were harvested 55 (early), 65, 75 (mature) and 85 (over-ripe) days after flowering and the seeds obtained from each harvest period were dried in three groups over $CaCl_2$ solution (%35 RH) at 25 (control), 35 and 45 ºC for 24 hours. Seed quality was determined by germination test, tetrazolium test, cold test and seedling root length. In all quality tests, there was no interaction between temperature and harvest periods, and it was determined that the best harvest period was 65 and 75 days harvest periods. Low values were determined in the 55th day (early) and 85th day (late) harvest periods. He reported that the most suitable harvest time in terms of resistance to drying is the period when the fruit is bright red, which corresponds to the 65th and 75th days after flowering. In our study, especially the 70th day was determined as the suitable seed harvest time for pepper.

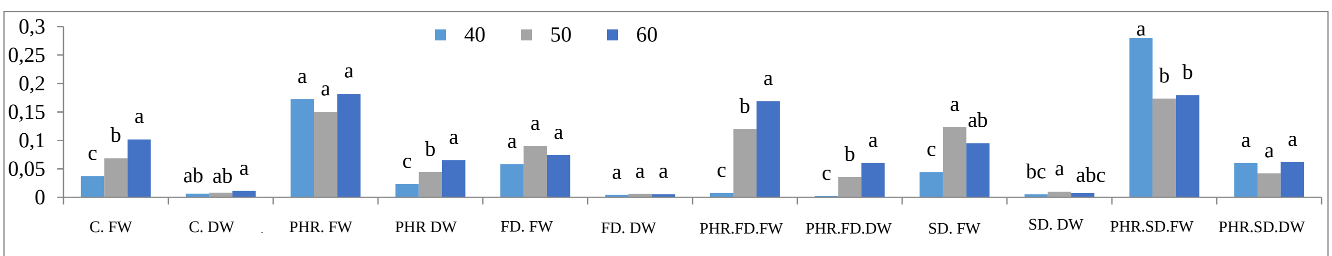


Harvestday*PHR*drying: p>0.05 (excluding MET), harvestday*drying: p>0.05 (excluding MET), P values indicate the significance of interaction between Harvestday and applications. The mean shown with different letters within the same application are statistically significant at the level of the specified P value.

Fig 5. Evaluation of pepper seeds of different maturity by 25°C seedling emergence test(%)(2019)

Evaluation of Fresh (FW) and Dry (DW) Weight (g) of Seedlings Obtained After Drying and Post-Harvest Ripening Applications of Pepper Seeds Harvested at Different Maturity Periods

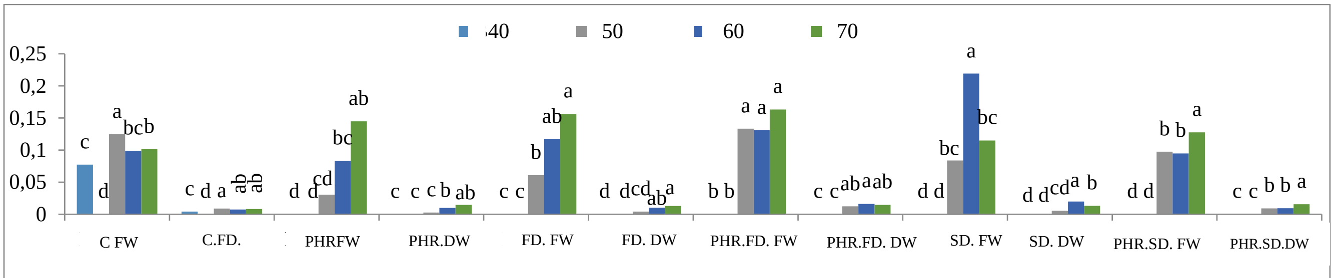
Seedling fresh and dry weight measurements of control (C), first and second drying method (FD, SD) and combinations (CFW, CDW, PHRFW, PHRDW, FDFW, FDDW, PHRFDFW, PHRFDDW, SDFW, PHRSDFW, PHRSDDW) of seeds of Burdem variety harvested at different maturity (40, 50, 60, and 70 days) periods are given in Fig. 6. In general, storage application and drying combinations increased the seedling fresh weight at all maturity. In the first year results, the highest seedling fresh-dry values; PHRSDFW-PHRSDDW was defined in the 40th day seeds, PHRSDFW-PHRDW in the 50th day harvest, and PHRFW-PHRDW in the 60th day harvest. FW and DW values were not found to be significant when harvest days and drying practices were considered on the basis of statistically obtained parameters (p>0,05) (Fig 6.). Hot pepper drying methods were evaluated on the basis of quality parameters such as physicochemical properties according to the combination of temperature and time. Higher viability index, germination, root length, shoot length, seedling dry weight and lower electrical conductivity, moisture content were recorded in sun-dried and mechanically dried seeds at 37°C. In addition to these, nutrients such as capsaicin, ash content, protein, ascorbic acid, and carbohydrates reached high values in this group. In general, the best results were obtained in sun and oven drying, while the worst results were obtained in drying in the shade and room conditions (Christinal and Tholkkappian, 2012). In our study, PHRSD applied to the seeds of the 40th day (immature seed) harvest significantly increased the seedling wet weight.



Harvestday*PHR*drying: p>0.05, harvestday*drying:p>0.05, P values show the significance of the interaction between Harvestday and applications. The mean shown with different letters within the same application are statistically significant at the level of the specified P value.

Fig 6 Fresh and dry weight of pepper seedlings of different maturity(2018)(g)

Seedling fresh-dry values were the highest in the 2nd year results; CFW-CDW in 40th day seedlings, PHRFDFW-PHRFDDW in 50th day seedlings, SDFW-SDDW in 60th day seedlings and PHRFDFW in 70th day seedlings were determined. DW values were statistically significant at the 1% level in harvest days and drying applications (p<0,01)(Fig 7.). Goncalves et al. (1998), in their study for the best seed harvest time in All-big pepper cultivar, the germination percentage and seedling growth of seeds taken 60 days after flowering (completely red) gave the best results (Goncalves et al.,1998). In our second year results, SD application, especially on 60th day harvest seeds, gave the highest seedling fresh weight.



Harvestday*PHR*drying: p>0.05, harvestday*drying:p>0.05, P values show the significance of the interaction between Harvestday and applications. The mean shown with different letters within the same application are statistically significant at the level of the specified P value.

Fig 7 Fresh and dry weight of pepper seedlings of different maturity(2019)(g)

Enzyme Activities of Pepper Seeds Harvested at Different Maturity Periods After Drying and Post-Harvest Ripening Applications

When the catalase enzyme activity results of the C, PHR, FD, FD+PHR, SD, SD+PHR groups of the seed lots of Burdem variety harvested at different maturity (50, 60 days) periods are evaluated, the highest values in all ripeness lots are in the C group (0,136-0.173). µmol/min/g) was determined. While APX value increased with PHR and SD (1.896-1.821µmol/min/g) applications, the highest increase was observed in SD (62.55-74.73U/g) application in SOD value according to maturity order. When the harvest days were considered on the basis of the parameters obtained statistically, the CAT value was found to be significant at the 1% level, while the CAT and SOD were significant at the 1% level in terms of drying applications ($p<0.01$). In the 2nd year results, CAT activity was determined in the FD and PHR (0.135;0.284µmol/min/g) groups with the highest values at 50, 60 days of the values obtained in the C group (0.132;0.226µmol/min/g). The highest SOD value was observed in PHR (31.05 U/g) application in 50 days seed lot (Table 4). When the harvest days are considered on the basis of statistically obtained parameters, CAT, SOD, and APX values were found to be significant at the level of 1%, while SOD, APX 1%, and CAT were found to be significant at the 5% level in terms of drying applications ($p<0,01$, $p<0,05$). SOD is an enzyme that acts against reactive oxygen forms and inhibits the action of radical superoxide (O_2) and catalyzes the reactions of electron transfers to produce hydrogen peroxide. In studies with pepper seeds, Vidigal et al. (2009) found a small increase in the intensity of SOD enzyme bands in seeds extracted from fruits harvested starting 50 days after anthesis and then stored for six days. In another study, antioxidant activity was highest in pepper seeds 15 days after flowering. However, it decreased steadily until the 50th day afterward. Seeds collected on the 15th day after flowering had high antioxidant content at the beginning of storage, but relatively decreased under shelf conditions after low-temperature storage (Park et al., 2020). Several studies have shown that ultra-dry treatment significantly affects the activities of antioxidant enzymes in seeds, thereby slowing the decline in the viability of seeds (Cui et al., 2014; Ali et al., 2017). According to our results, CAT activity in the seeds of 60-day harvests in C and PHR groups; SOD activity in SD the group in the first year and in group C in the second year; APX activity in C and PHR group seeds gave high values. The changes in fruit size could have been caused by the minimal moisture loss that occurred during the post-harvest ripening (PHR) period. For bottle gourd, pepper, chili, similar effects of seed moisture loss with delayed PHR harvesting were observed (Alan and Eser, 2008). In accordance with Vidigal et al. (2009), the release of moisture from immature capsicum seeds during PHR stresses the seeds, causing ROS generation to increase and antioxidant enzyme activity to scavenge ROS to increase.

Table 4. Enzyme activity of pepper seeds harvested at different maturity times after drying and post-harvest ripening applications

		2018			2019		
		CAT (µmol/min/g FW)	**APX (µmol/min/g FW)**	**SOD (U/gFW)**	**CAT (µmol/min/g FW)**	**APX (µmol/min/g FW)**	**SOD (U/gFW)**
P50	**C**	**0,136 b**	1,411 a	12,04 b	0,132 b	**1,579** b	18,73 b
P60		**0,173 a**	1,543 a	30,99 a	0,226 a	**3,068** a	**63,02** a
P50	**PHR**	0,136 a	**1,896** a	17,26 b	0,060 b	0,761 b	**31,05** a
P60		0,145 a	1,304 b	26,33 a	**0,284** a	2,600 a	28,98 a
P50	**FD**	0,100 a	1,086 a	5,66 a	**0,135** b	0,782 b	7,24 a
P60		0,107 a	1,304 a	9,77 a	0,218 a	1,839 a	12,01 a
P50	**FD+PHR**	0,074 b	1,154 b	14,35 b	0,055 a	1,389 a	17,06 a
P60		0,115 a	1,746 a	22,66 a	0,072 a	1,193 b	17,47 a
P50	**SD**	0,083 a	1,482 a	**62,55** a	0,068 b	1,154 b	11,06a
P60		0,036 b	**1,821** a	**74,73** a	0,187 a	2,957 a	10,95a
P50	**SD+PHR**	0,090 b	0,882 a	36,00 a	0,043 b	1,071 a	16,39 b
P60		0,162 a	1,107 a	12,17 b	0,205 a	1,357 a	51,99 a

Harvestday*PHR*drying: p<0.01 (CAT), harvestday*drying: p>0.05, P values show the significance of the interaction between Harvest day and applications. The mean shown with different letters within the same application is statistically significant at the level of the specified P value.

Harvestday*PHR*drying:p<0.01, p<0.05 (excluding CAT), harvest day*drying: p<0.01(excluding CAT), P values indicate the significance of the interaction between Harvestday and applications. The mean shown with different letters within the same application is statistically significant at the level of the specified P value.

Conclusion

During the drying process of seeds, drying temperature and seed moisture content gain importance. If the critical temperature is exceeded, high temperatures carry a risk due to possible damage to the embryo. The general rule in the drying process is to increase the drying temperature after drying with a low temperature at the beginning for seeds containing high humidity. In the germination test of pepper seeds of different maturity, when the advantage/disadvantage situation was evaluated for the total germination parameter compared to the control seeds of the applications, no significant advantages were obtained in general. However, FD (1st year) application for 40-day-old seeds had an advantage compared to control groups (2nd year) in SD applications at 60-day harvest. In the seedling emergence test of pepper seeds of different maturity, when the advantages/disadvantages of the applications are evaluated for the total emergence parameter according to the control seeds, the advantages of the applications vary according to the seed maturity periods. In the first year, the highest advantages were obtained from FD+PHR for 50-day seeds and SD for 60-day harvests, while in the second year, FD and FD+PHR on the 70th day and FD+PHR on the 50th day were determined. Dry weight (DW) values were statistically significant at the level of 1% in pepper seed lots in the second year, on harvest days and drying applications ($p<0.01$). CAT activity in pepper results in 60 days of harvested seeds in C and PHR groups; SOD activity was SD in the first year and in group C in the second year; APX was found to be high in C and PHR applications. Harvestday*drying interaction was not found significant in the first year ($p>0.05$, 0.01), whereas Harvest day*PHR*drying interaction is significant for APX and SOD in the second year. Considering the field conditions in which we conducted our study, the 60th day of the first year and the 70th day of the second year after anthesis were found suitable for seed harvesting.

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Conflict of Interest
This research is a part of Yasemin Çelik's master thesis. Burcu Begüm Kenanoğlu is the supervisor and corresponding author.

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