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THE QUALITY OF SEEDS OF DIFFERENT CULTIVARS OF PEPPER (CAPSICUM ANNUUM LINN) PROCESSED BY DIFFERENT METHODS

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Abstract

An investigation was conducted in the screen house of Crop Production Department, Federal University of Technology, Minna, Niger State, Nigeria to determine the effect of two seed extraction methods (extraction of seeds from wet ripe fruits and extraction of seeds from dry fruits and two drying methods (sun and air) on seed quality of six pepper (Capsicum annuumL.) cultivars. The cultivars used were 'Rodo-Dan Sokoto' (RD-DSK), 'Rodo Dan-Brini-Gwari' (RD-DBG), 'Tatashe Dan Kano' (TS-DKA), 'Tatashe Dan Kaduna' (TS-DKD), 'Shombo Dan Sokoto' (SB-DSK) and Shombo Dan Guru' (SB-DGU). The study was a 2 X 2 X 6 factorial experiment subjected to the Completely Randomized Design. The seeds of the different treatment combinations were placed in open containers and stored at 80% relative humidity and 35°C for eight weeks. Seedling emergence test was conducted every-other-week. Seeds of cultivar 'Shombo-Dan Guru' (SB-DGU) seeds generally recorded significantly higher seedling emergence percentage, longer seedling and lower electrical conductivity (EC) and greater longevity were recorded in cultivar 'Shombo' than in the other cultivars. Seeds of cultivar 'TS-DKA' recorded significantly lower values for all parameters except EC compared to all other genotypes. Seeds extracted from wet fruits before drying maintained viability for a longer period than those from dry fruits. Shade-drying resulted in significantly higher germination than sun-drying all through the storage period except in SB-DGU. The study revealed that longevity was better maintained when seeds of different pepper cultivars were extracted from wet fruits and afterwards dried in shade except in TS-DKA in which seeds extracted from shade-dried fruits had significantly greater quality than those of its other treatment combinations. Significant interaction effects of cultivar, extraction and seed drying methods were also recorded. Seed viability, seedling emergence and length declined with age while EC increased with age.

Keywords: Cultivar, extraction, drying and emergence.

INTRODUCTION

The genus Capsicum consists of over 100 species and even more botanical varieties (Ado, 1999; Falusi, 2007). It includes five domesticated species (Capsicum annuum, Capsicum frutescens, Capsicum baccatum, Capsicum chinense and Capsicum pubescens) which are all believed to have originated from the New World (Mc Leod et al., 1982; Bosland, 2004).Fresh pepper is a very good source of vitamin C and E and as well as provitamin A and carotenoids; it is also known for its antioxidants properties (Serrano-Martinez et al., 2008). Chilies are important vegetable crops and used world-widely as for flavour, aroma and add colour to foods (Zhuang et al., 2012). Therefore, the demand for high quality seeds has grown substantially in recent years, which requires that seed companies adopt advanced technologies during production, processing and storage processes (Caixetaet al., 2013). Seed quality depends on among others, techniques of harvesting and processing (which includes seed extraction and drying method) and storage practices. Different drying methods such as sun drying, shade drying, use of silica gel and the use of seed dryer are with varying implications. In countries where agriculture is well developed, seed processing is highly mechanized. Dryers are designed for efficient and effective reduction of seed moisture to levels deemed safe for viability preservation during storage. Such facilities are not readily available in developing countries. Even where available, they may not be affordable to resource-poor vegetable seed producer. Both sun- and shade-drying are low input methods and therefore, readily available and affordable.There seems to be no specific recommendation in respect of the seed extraction method to be adopted by pepper seed producers. Some researchers dried seeds following extraction from fresh fruits while others extracted seeds from dry fruits. Most farmers in Nigeria practice the latter.Seeds of different cultivars of the same species may also respond differently to the same drying method.

It is therefore necessary to determine the quality response of different cultivars to seed extraction and drying methods.

The objective was to determine the effects of different seed extraction and drying methods on seedling emergence, length and electro conductivity of leachate of seeds of the different treatments.

MATERIALS AND METHODS

The experiment was conducted in the Crop Production laboratory and screen house of the Federal University of Technology Gidan-Kwano campus, Minna(latitude 9'22°N and longitude 6'15°E) in the southern Guinea savannah ecological zone of Nigeria.Fruits of six (6) cultivars of pepper namely, 'Rodo Dan Sokoto'(RD-DSK), 'Rodo Dan Brini-Gwari' (RD-DBG), 'Tatashe Dan Kano' (TS-DKA), 'Tatashe Dan Kaduna' (TS-DKD), 'Shombo Dan Sokoto' (SB-DSK), 'ShomboDan Guru' (SB-DGU) were sourced from farmers in Kaduna, Kaduna State.Fruits of each cultivar were divided into four lots. Fruits of the first lot of each cultivar were cut open and the seeds extracted from them were washed and then sundried. Seeds extracted from the second lot of each cultivar were also washed but air-dried on the bench in ambient condition in the laboratory. The fruits of the third lot were kept intact and sundried while the fruits of the fourth lot were also kept intact but air-dried on bench in the laboratory. Seeds from the last two lots were later extracted from the dried fruits. 1
A sample of seeds of each of the treatment combinations was spread in open plastic plates and then placed in an incubator at 35 °C and relative humidity of about 80% for accelerated ageing (Delouche and Baskin, 1973)for 8 weeks and samples were drawn for germination test prior to storage and at two weeks intervals after wards for 8 weeks. Four replicates of 10 seeds each of each treatment were sown into sharp sand in plastic pots in the screen house at 0, 4 and 8 weeks of storage. The pots were watered just before sowing the seeds and then daily after sowing. Data were collected daily on seedling emergence percentage and seedling length at two weeks intervals.

Emergence percentage was calculated thus:

$$EP = \frac{Ne}{Nt} \frac{100}{1} \text{(Kader, 2005)}.$$

Where, Ne is total number of emerged seedlings; Nt is total number of seeds sown.

Seedling length was measured from the root tip to the shoot apex using a ruler. At the onset of storage and at 4 and 8 weeks of storage, 100 seeds of each treatment were weighed and then soaked in 40 ml distilled water for 24 hrs. The electrical conductivity of the soak water (leachate) was measured in duplicates using Jen-way conductivity meter (model- DDS-307), and the results were expressed as mean $\mu S\ cm^{-1}\ g^{-1}$ seeds (ISAT 1995). This was done to determine changes in cell membrane integrity at different storage periods.

All the data collected were subjected to analysis of variance (ANOVA) for completely randomized design (CRD) using SAS Statistical Package 9.2. Means were separated using the Student-Newman-Keuls (SNK) test. Data in percentages were transformed to arcsin values before statistical analysis.

Result

Table 1 shows the effects of cultivar, extraction and drying methods on seedling emergence percentage. The highest value recorded for SB-DSK (69%) And RD-DGU (69%) at 0WAS which were at par were significantly greater than those other cultivar; the value of 26% recorded in TS-DKA was significantly lower than those of all other cultivars. At 4 WAS the highest EP (61%) recorded for SB-DGU was similar to those of SB-DSK,RD-DSK and RD-DBG. The 33% recorded in TS-DKA was significantly lower than those of all other accessions. The similar values recorded for SB-DSK and SB-DGU at 8 WAS were significantly greater than those of other accessions. Seeds extracted from wet fruits before drying (E1) recorded significantly higher emergence percentages compared to seeds extracted from dry fruits (E2) at both 0and 4 WAS but the values were similar at 8WAS. Also air-drying (D2) resulted in seeds with significantly higher emergence compared to sun-drying (SD) at 0 and 4 WAS; values for both drying methods were similar at 8 WAS when C X E interaction was significant.

Table 1: Effects of cultivar, drying method and extraction method on the emergence percentage of *Capsicum annuumseeds*.

Storage period (weeks)	0	4	8
Cultivar			
RD-DSK (C1)	478b	54ab	21b
RD-DBG (C2)	46b	56ab	23b
TS-DKA (C3)	26c	33c	14b
TS-DKD (C4)	49b	46b	22b
SB-DSK (C5)	68a	57a	44a
SB-DGU (C6)	69a	61a	34a
Extraction method ()			
Wet fruit (E1)	63a	66a	23a
Dry fruit(E2)	39b	37b	28a
Drying method (D)			
Sun (D1)	44b	42b	24a
Air (D2)	58a	60a	28a
Interaction			
C X E	*	*	N.S
C X D	*	*	*
E X D	*	*	*
C X E X D	*	*	*

Values followed by same letter under each factor and storage period are not significantly different (p=0.05).

*= Significant; NS= non-significant

Table 2 shows that at both 0 and 4 WAS seedling emergence was significantly higher in all cultivars except TS-DSK when seeds were extracted from fresh fruits before drying than when extracted from dried fruits. The parameter was not significantly affected by drying method in TS-DKA.

Table 2: Interaction effect of cultivar and extraction method (wet fruit-E1 and dry fruit-E2) on seedling emergence percentage.

	Storage period (weeks)	
Cultivar X Extraction	0	4
C1 E1	60c	71bc
C1 E2	35e	36ef
C2 E1	63bc	73b
C2 E2	29f	40e
C3 E1	25f	31g
C3 E2	28f	34fg
C4 E1	65b	68c
C4 E2	34e	25h
C5 E1	83a	74ab
C5 E2	53d	40e
C6 E1	83a	78a
C6 E2	55d	45d

Values followed by the same letter under each storage period are not significantly different (p=0.05).

Table 3 shows thatat 0 and 4WAS, air-drying of seeds resulted in significantly higher seedling emergence than in sun-drying in all cultivars except in SB-DGU where the reverse was the case. The trend was almost the same at8 WAS except in TS-DKA in which no significant difference was recorded between sun-dried and air-dried seeds.

Table 3: Interaction effect of cultivar and drying method (sun-drying-D1 and shade-drying-D2) on seedling emergence percentage.

	Storage period (week)		
Cultivar X Drying	**0**	**4**	**8**
C1 D1	35fg	35g	13g
C1 D2	60cd	73b	30c
C2 D1	34g	43f	18ef
C2 D2	58d	70ab	28cd
C3 D1	14h	20h	13g
C3 D2	39ef	45f	15fg
C4 D1	43e	36g	20e
C4 D2	56d	56d	24d
C5 D1	53c	51e	41b
C5 D2	73b	79a	46a
C6 D1	78a	73c	43b
C6 D2	60cd	58d	25d

Values followed by the same letter under each storage period are not significantly different (p=0.05).

Table 3: Interaction effect of cultivar and drying method (sun-drying-D1 and shade-drying-D2) on seedling emergence percentage.

	Storage period (week)		
Cultivar X Drying	**0**	**4**	**8**
C1 D1	35fg	35g	13g
C1 D2	60cd	73b	30c
C2 D1	34g	43f	18ef
C2 D2	58d	70ab	28cd
C3 D1	14h	20h	13g
C3 D2	39ef	45f	15fg
C4 D1	43e	36g	20e
C4 D2	56d	56d	24d
C5 D1	53c	51e	41b
C5 D2	73b	79a	46a
C6 D1	78a	73c	43b
C6 D2	60cd	58d	25d

Values followed by the same letter under each storage period are not significantly different (p=0.05).

Table 4 shows that at drying method did not significantly influence seedling emergence percentage from seeds extracted from fresh fruits (E1) at both 0 and 8WAS. AT 4WAS, air-drying resulted in significantly higher emergence percentages than sun-drying. The magnitude of increase from D1 and D2 was howevergreater (28%) when fruits were dried before seeds were extracted from them (E2) compared to 8% when seeds were extracted prior to drying (E1).

Table 4: Interaction effect of extraction (wet fruit-E1 and dry fruit -E2) and drying method (sun-drying-D1 and shade-drying-D2)on seedling emergence.

Storage period (weeks)			
Extraction X Drying	**0**	**4**	**8**
E1 D1	63a	62b	34a
E1 D2	63a	70a	31a
E2 D1	25c	23d	15c
E2 D2	53b	51c	25b

Values followed by the same letter under each storage period are not significantly different (p=0.05).

Table 5 shows the effect of cultivar, extraction and drying method interaction on seedling emergence percentage. When sun-drying (D1) method was used for all cultivars, seedling emergence percentage was significantly higher in E1 than in E2 extraction method at all storage periods. When air-drying (D2) method was adopted, seedling emergence was significantly greater in E1than E2 extraction method in TS-DKD (C4), SB-DSK (C5) and SB-DGU (C6) all through the storage period; at 0 and 4WAS in RD-DBG (C2) and 4 WAS in RD-DSK (C1). The values for E2 were significantly greater than those of E1 seeds in TS-DKA (C3) at 0, and 4 WAS. Furthermore, the use of seeds extracted from air-dried (D2) fruits resulted in significantly greater seedling emergence compared tothose extracted from sun-dried (D1) seeds in all cultivars except in SB-DGU (C6) in which the reverse was recorded.

Table 5. Interaction effect of cultivar, extraction (wet fruit-E1 and dry fruit -E2) and drying method (sun-drying-D1 and shade -drying-D2)on emergence percentage of *Capsicum annuum*seeds at 0-8 weeks of storage (WAS).

Cultivar X Extraction X Drying	Storage period (weeks) 0	4	8
C1E1D1	63g	63de	25f
C1E1D2	58h	80a	18g
C1E2D1	7.5m	8k	0j
C1E2D2	63fg	65d	43bc
C2E1D1	60gh	70c	30e
C2E1D2	65ef	75b	25f
C2E2D1	7.5m	15j	5i
C2E2D2	50i	65d	30e
C3E1D1	20l	30h	18g
C3E1D2	30k	33h	15gh
C3E2D1	7.5m	10k	8i
C3E2D2	58i	58fg	15gh
C4E1D1	68e	55g	35d
C4E1D2	63fg	80a	35d
C4E2D1	18l	18j	5i
C4E2D2	50i	33h	13h
C5E1D1	88a	78ab	58a
C5E1D2	78c	70c	58a
C5E2D1	38j	25i	25f
C5E2D2	68e	55o	35d
C6E1D1	83b	75b	40c
C6E1D2	83b	80a	35d
C6E2D1	73d	60ef	45b
C6E2D2	38j	30h	15gh

Values followed by the same letter under each storage period are not significantly different (p=0.05).

Significant differences in electroconductivity (EC) values among the different cultivars were recorded at all storage periods. At 0 WAS, the highest EC (0.34 $\mu S^{-1} cm^{-1} g$) was recorded in TS-DKA but the value was not significantly different from those of RD-DSK, RD-DBG, TS-DKD and SB-DSK. The lowest EC value (0.19 $\mu S^{-1} cm^{-1} g$) recorded in SB-DGU was only significantly different from that of TS-DKA. Seeds extracted from dry fruits recorded significantly higher EC (0.47 $\mu S^{-1} cm^{-1} g$) than those from wet fruit (0.09 $\mu S^{-1} cm^{-1} g$). Drying method did not significantly affect EC except at 4 WAS when sun-drying resulted in a higher EC value (0.32 $\mu S^{-1} cm^{-1} g$) than in the air-dried (0.29$\mu S^{-1} cm^{-1} g$). At 4 WAS, the value recorded for TS-DKA was significantly higher than all the other values; the lowest in SB-DGU (0.231 $\mu S^{-1} cm^{-1} g$) was significantly different form all the others. EC was significantly higher in seeds extracted from dry fruits (0.54 $\mu S^{-1} cm^{-1} g$) than in those from fresh fruits (0.08 $\mu S^{-1} cm^{-1} g$). Furthermore, higher EC was recorded in sun-dried (0.32 µS^{-1}cm^{-1}g) than in shade-dried (0.29 µS^{-1}cm^{-1}g). At 8 WAS, the highest EC of 0.57 µS^{-1}cm^{-1}g recorded for TS-DKD was only significantly different from the value recorded for RD-DBG which in turn was at par with those of RD-DSK, SB-DSK and SB-DGU.

Table 10: Effect of cultivar, drying method and extraction method on electro conductivity (µS^{-1}cm^{-1}g) of *Capsicum annuum*seed leachate at 0, 4 and 8WAS

	Storage period (weeks)		
	0	4	8
Cultivar (C)			
RD-DSK (C1)	0.32ab	0.36b	0.50ab
RD-DBG (C2)	0.29ab	0.25e	0.41b
TS-DKA (C3)	0.34a	0.37a	0.55a
TS-DKD (C4)	0.28ab	0.33c	0.57a
SB-DSK (C5)	0.25ab	0.29d	0.50ab
SB-DGU (C6)	0.19b	0.23f	0.46ab
Extraction Method (E)			
Wet Fruit (E1)	0.09b	0.08b	0.27b
Dry Fruit (E2)	0.47a	0.54a	0.73a
Drying Method (D)			
Sun (D1)	0.31a	0.32a	0.51a
Air (D2)	0.25a	0.29b	0.49a
Interaction			
C x E	*	*	*
C x D	*	*	*
E x D	N.S	*	*
C x E x D	*	*	*

A significant C x E, C x D, E x D and C x E x D interaction was observed for EC values at 0, 4, and 8 WAS.

Significant C X E interactions were recorded at all storage periods. At 0 WAS, significantly higher EC were recorded in seeds extracted from dry fruit than in those of wet fruits in all cultivars except in RD-DBG in which EC values for wet and dry fruit extraction methods were similar. Furthermore, whereas E1 values were similar among all cultivars, significant differences in EC values were recorded among cultivars in respect of E2; the value (0.62µS^{-1}cm^{-1}g) recorded for E2 in TS-DKA (C3) is significantly higher than those of RD-DBG (C2) and SB-DGU (C6). At 4 WAS EC values were significantly different among cultivars when seeds were extracted from dry fruits, whereas seeds of cultivars RD-DSK (C4) and RD-DBG from wet fruits were similar in EC but were both significantly different from those of all other cultivars. At 8 WAS, there were no significant differences among the EC values of the different cultivars when wet fruit (E1) extraction method was used. When the dry fruit (E2) extraction method was used, the highest EC of 0.86 µS^{-1}cm^{-1}g recorded for TS-DKD was significantly different from that of RD-DBG (0.56 µS^{-1}cm^{-1}g) but similar to the values recorded for the other cultivars (0.64-0.84 µS^{-1}cm^{-1}g). Also the value (0.56 µS^{-1}cm^{-1}g) recorded for RD-DBG was similar to those of RD-DSK, SB-DSK and SB-DGU.

Table 11: Interaction effect of cultivar and extraction method on electro-conductivity ($\mu S^{-1}cm^{-1}g$) of *Capsicum annuum*seed leachate at 0, 4 and 8 WAS.

Cultivar X Extraction	Storage period (weeks) 0	4	8
C1 E1	0.07e	0.09g	0.29c
C1 E2	0.57ab	0.64b	0.71ab
C2 E1	0.22de	0.08g	0.25c
C2 E2	0.37bcd	0.42e	0.56b
C3 E1	0.07e	0.07h	0.26c
C3 E2	0.62a	0.67a	0.84a
C4 E1	0.05e	0.07h	0.28c
C4 E2	0.50abc	0.58c	0.86a
C5 E1	0.06e	0.07h	0.27c
C5 E2	0.44abcd	0.51d	0.74ab
C6 E1	0.05e	0.06k	0.27c
C6 E2	0.33cd	0.40f	0.64ab

Values followed by the same letter under each storage period are not significantly different ($p=0.05$).

At 0 WAS, no significant interaction was recorded between sun-dried and air-dried seeds in all cultivars except in TS-DKA in which EC was greater in the sun-dried than in the air-dried seeds. At 4 WAS air-drying resulted in significantly higher EC compared to sun-drying in RD-DSK (C1), TS-DKD (C4), SB-DSK (C5) and SB-DGU (C6) while the opposite was the case in RD-DBG (C2) and TS-DKA (C3). Also all C X D interaction values were significantly different from each other except for the similarity in the EC values of RD-DBG (C2) air-dried seeds and SB-DGU (C6) dried in the sun. The EC values of seeds of all cultivars were not significantly affected by drying method in all cultivars except in TS-DKA in which significantly higher EC was recorded in sun-dried seeds (D1) than in the ones air-dried (D2). Also, while air-dried seeds of all cultivars had similar EC, sun-dried seeds of TS-DKA recorded significantly higher EC than sun-dried (D1) seeds of RD-DBG.

Table 12: Interaction effect of cultivar and drying method on electro-conductivity ($\mu S^{-1}cm^{-1}g$) of *Capsicum annuum*seed leachate at 0, 4 and 8 WAS

Cultivar X Drying	Storage period (weeks) 0	4	8
C1 D1	0.32ab	0.35c	0.45ab
C1 D2	0.32ab	0.36b	0.55ab
C2 D1	0.39ab	0.28g	0.39b
C2 D2	0.20b	0.22k	0.42b
C3 D1	0.47a	0.45a	0.68a
C3 D2	0.22b	0.24j	0.42b
C4 D1	0.25ab	0.32e	0.59ab
C4 D2	0.30ab	0.34d	0.55ab
C5 D1	0.21b	0.27h	0.48ab
C5 D2	0.30ab	0.31f	0.53ab
C6 D1	0.19b	0.22k	0.46ab
C6 D2	0.19b	0.24l	0.46ab

Values followed by the same letter under each storage period are not significantly different ($p=0.05$).

At 0 WAS although drying method did not affect EC values significantly within each extraction method, the magnitude of reduction from sun (D1) to air-drying (D2) was greater in the wet fruit (E1) than in dry fruit (E2) extraction method. At 4 WAS,air-drying resulted in significant decline in EC than in sun-drying irrespective of extraction method. However, the decline was greater when dry fruit extraction method was used (about 0.07μS^{-1}cm^{-1}g) than when wet fruit extraction method was used (about 0.01 μS^{-1}cm^{-1}g 1). At 8 WAS, drying method had no significant effect on the EC of seeds of the two extraction methods. However whereas air-drying of seeds extracted from wet fruits resulted in an increase of about 0.04 μS^{-1}cm^{-1}g compared to the sun-dried lot, fruits air-drying resulted in an EC decrease of about 0.07 μS^{-1}cm^{-1}g compared to sun-drying.

Table 1 2. Interaction effect of extraction and drying method on electro-conductivity (μS^{-1}cm^{-1}g) of *Capsicum annuum*seed leachate at 0, 4 and 8 WAS.

Storage period (weeks)			
Extraction X Drying	0	4	8
E1 D1	0.12b	0.08c	0.25b
E1 D2	0.06b	0.07d	0.29b
E2 D1	0.49a	0.57a	0.76a
E2 D2	0.45a	0.50b	0.69a

Values followed by the same letter under each storage period are not significantly different (p=0.05).

At 0WAS, drying method did not significantly affect EC values of seeds extracted from fresh fruit in all cultivars. The trend was similar in seeds extracted from dry fruits except in TS-DKA (C3) in which sun-drying resulted in significantly higher EC than air-drying. The EC value of 0.86μS^{-1}cm^{-1}gwas significantly higher than those recorded for all other seed lots except in seed of RD-DSK (C1) extracted from sun- and air-dried fruits and those of TS-DKD (C4) and SB-DSK (C5) extracted from air-dried fruits. In RD-DSK (C1) and TS-DKD (C4)the EC values for E1D1 and E1D2 combinations were significantly lower than those of E2D1 combinations whereas in RD-DBG (C2) and SB-DGU (C6), EC values were similar for all extraction and drying method combinations. At 4 WAS, RD-DSK (C1), TS-DKD (C4) and SB-DGU (C6) seeds extracted from fresh fruits had significantly lower EC when air-dried than when sun-dried whereas the reverse was the case in seeds extracted from dry fruits. In RD-DBG (C2) drying method did not have a significant effect on the EC values of seed extracted from fresh fruits while seeds extracted from sun-dried fruits recorded significantly higher EC than those from air-dried fruits. In TS-DKA (C3) sun-drying resulted in higher EC irrespective of the seed extraction method. The EC (0.92μS^{-1}cm^{-1}g) value recorded for this cultivar when seeds were extracted from sun-dried fruits was significantly higher than those of all other C X D X E interactions. Air-drying resulted in significantly higher EC values than when sun-drying method was adopted for SB-DSK (C5) irrespective of the extraction method used. At 8 WAS, drying method did not significantly affect EC values of seeds extracted from fresh fruits in all cultivars. The trend was almost repeated in seeds extracted from dry fruits except in TS-DKA (C3) in which sun-drying resulted in significantly higher EC than in air-drying. General increases in EC values were recorded for all cultivars, extraction and drying combinations throughout the storage period. Furthermore, TS-DKA (C3) seeds extracted from sun-dried fruits recorded the highest EC (0.86-1.10μS^{-1}cm^{-1}g) throughout the storage period.

Table 1 3: Interaction effect of cultivar, extraction and drying method on electro-conductivity (μS-1cm-1g) of *Capsicum annuum*seed leachate at 0, 4 and 8 WAS.

Cultivar X Extraction X Drying	Storage period (weeks)		
	0	4	8
C1 E1 D1	0.10c	0.10k	0.28d-h
C1 E1 D2	0.04c	0.07o	0.29d-h
C1 E2 D1	0.54ab	0.61c	0.61b-f
C1 E2 D2	0.59ab	0.66b	0.81abc
C2 E1 D1	0.39bc	0.09l	0.21h
C2 E1 D2	0.05c	0.08lm	0.28d-h
C2 E2 D1	0.39bc	0.48f	0.58b-g
C2 E2 D2	0.35bc	0.36j	0.54c-h
C3 E1 D1	0.08c	0.08lm	0.26fgh
C3 E1 D2	0.06c	0.06p	0.26fgh
C3 E2 D1	0.86a	0.92a	1.10a
C3 E2 D2	0.37bc	0.42h	0.59b-g
C4 E1 D1	0.04c	0.09l	0.26fgh
C4 E1 D2	0.06c	0.07n	0.30d-h
C4 E2 D1	0.52b	0.55d	0.92ab
C4 E2 D2	0.53ab	0.61c	0.80abc
C5 E1 D1	0.05c	0.06pq	0.22gh
C5 E1 D2	0.07c	0.08m	0.31d-h
C5 E2 D1	0.37bc	0.48f	0.73abc
C5 E2 D2	0.52ab	0.54e	0.75abc
C6 E1 D1	0.06c	0.07o	0.28d-h
C6 E1 D2	0.05c	0.06pq	0.27efgh
C6 E2 D1	0.32bc	0.37i	0.63bcde
C6 E2 D2	0.33bc	0.43g	0.64bcd

Values followed by the same letter under each storage period are not significantly different ($p=0.05$).

Discussion

The significant differences in percentage seedling emergence in this study agree with other studies Hunjeet al. (2007) likewise observed variation between two varieties of pepper. Significant variations in respect of emergence percentage in pea varieties also reported by Jatoi et al. Such variations have been attributed to difference in genetic makeup of the cultivars.

Seeds extracted from wet fruits before drying were generally superior to those extracted from dry fruits in respect of the parameters evaluated. Available information seems to be non-specific as to the extraction method that should preferably be adopted for pepper. Sukprakanet al. (2005) and AVRD (2005) suggested that pepper seed may be extracted from fresh fruits or fruits that have been dried in the sun for a few days. The general practice among pepper farmers in Nigeria and other developing countries of the world seems to be that of sun-drying of fruits followed by seed extraction. Savarajet al. (2008) observed that the wet extraction was beneficial to seedlingvigour of eggplant. Rahman et al. (2015) also advocated that seeds of eggplant be extracted by wet method and then shade-dried to ensure high quality.

The current study furthermore, revealed that drying method did not generally affect the quality of seed that were extracted from fresh fruits before drying in the sun or shade whereas seeds from air-dried fruits were generally of poor quality compared to sun-dried fruits. The poorer quality recorded in seeds extracted from sun-dried fruits maybe due to over-heating of seeds in fruits especially in all the cultivars except SB-DGU while the moisture content of the seed is high. Contrary to this report, Hunje et al. (2007), Christinal and Tholkkappian (2012) and Krishnamurthy (1995) recorded better seed quality when fruits were dried in sun than those dried in the shade. The reason given was that slow-drying of seeds in the shade must have resulted in deterioration which manifested in poor field emergence. This is perhaps what happened in SB-DGU. Muthoka (2003) reported that neither sun nor shade drying were detrimental to seed quality in Milletialeucantha.

The increase inseedling emergence percentages with storage time especially in RD-DSK and RD-DBG this study was probably due to loss of dormancy which is known to exist in freshly harvested seeds of most crop species and is lost after some period of storage. This is in agreement with earlier findings of Oladiran and Kortse (2002)which showed that 'Rodo' seeds were dormant at harvest and recorded improvement on germination after storage. Lee et al. (2002) also reported that seed storage is known to break dormancy in some species. The decline in seedling emergence percentage after attainment of maximum point in this study suggests that deterioration sets in with progress in storage. Copeland et al. (2001) reported that seed vigor usually decreases with time in storage.

This study further revealed significant differences in the electroconductivity (EC) of the solute leachate from seed of different cultivars and seed handling treatments. Abreu et al. (2011) stated that EC test is employed to evaluate the extent of damage caused to cell membranes resulting from seed deterioration. The higher the reading, the poorer the vigour of a seed lot (Vidigalet al. 2011). It therefore follows that there were variations in the potential vigour of seeds of the different cultivars of pepper used in the current study prior to storage. De Carvalhoet al. (2009) listed genotype as one of the factors capable of affecting EC results. Szemruchet al. (2015) reported that high oleic genotype of sunflower had higher EC values which correlated with lower germination percentage. Panobianco and Vieira (1996), Vieira et al. (1999) also reported that EC varied significantly with genotype in pea. In this study, EC values were generally significantly lower in seeds of RD-DSK (C1) and TS-DKD (C4) extracted by wet method compared to those seeds extracted by dry method in both varieties indicating that seeds from wet fruits had better cell membrane integrity and hence more vigourous. This result is contrary to that of Christinal and Tholkkappian (2012) which showed that higher EC values were obtained from the leachate of air-dried pepper seed compared to those dried in the sun. The authors are of the opinion that slow drying was responsible for the poor quality of air-dried seeds. The increase in EC values as storage progressed in the current study is in agreement with the work of Mirdadet al. (2006) and Demiret al. (2008) in respect of cabbage seeds subjected to controlled deterioration, which is an indication of increasing loss of membrane integrity with increase in storage. Maximum electrical conductivity coincided with the lowest seedling emergence while lower EC values were recorded when seed vigour was high. Vieira et al. (1999) also reported that higher EC value was an indicator of lower vigour, due to an increase in membrane permeability of lower vigour seeds.

5.2 Conclusion

It is concluded that seeds SB-DSK and SB-DGU performed better than those of RD-DSK and RD-DBG which were in turn better than those of TS-DKA and TS-DKD. Seeds extracted from wet fruits prior to drying recorded better seedling emergence than those extracted from dry fruits in all cultivars except in TS-DKA where seed extracted from air-dried fruits were of better quality than those extracted from wet fruits (irrespective of drying method) and those extracted from sun-dried fruits. Also, seeds extracted from fruits prior to drying recorded lower EC than those from dried fruits. Seeds extracted from sun-dried fruits of TS-DKA recorded the highest EC values. The study also revealed that the use of seeds from air-dried fruits resulted in seedling emergence than those from sun-dried fruits in all cultivars except SB-DGU. Seedling emergence percentage declined in all cultivars after some period of storage irrespective of seed extraction and drying methods. Electro-conductivity of seed leachate increased with storage period.

5.3 Recommendation

It is recommended from this study that to obtain highseedling emergence percentage, pepper seeds should be extracted from wet fruits and then dried in the sun or shade.

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