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Influence of drying methods and packaging materials on seed quality and storability of watermelon (*Citrullus lanatus* (Thunb.) Matsum & Nakai) seeds

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Abstract

Watermelon is relished across the world because of its pulp that is thirst quenching and highly nutritious. The continuous supply of watermelon depends on the availability of quality seeds which is a function of seed quality during storage. This study investigated the effects of seed drying methods and storage containers on the physiological quality and storability of some watermelon varieties. The experiment was a 4 x 4 x 3 factorial experiment (4 varieties, 4 drying methods and 3 packaging materials) in a completely randomized design with 3 replications. The seeds of the four watermelon varieties (Sugar baby, Kaolak, Black diamond and Winter king) were sun dried, oven dried, air dried and dried with silica gel before storing in paper bag, polythene bag and plastic container. The seeds were stored for six months under ambient temperature (27.5°C, RH = 64.7%). The stored seeds were assessed for physiological attributes at 30-day intervals. Data collected were subjected to Analysis of Variance and means separated using Tukey's HSD test at 5% probability level. PROBIT analysis was also carried out to estimate the storage life of the seeds. Significant differences were observed in the seed physiological quality traits examined in the watermelon seeds due to differences in variety, seed drying methods and storage containers. Black diamond seeds exhibited a high viability rate of 92.6 and 76% and seed germination index of 11.58 and 9.51 respectively, before and after storage. Sun drying and oven drying methods greatly reduced the rate at which the watermelon seeds deteriorated. Oven drying method reduced germination percentage of the watermelon seeds. The PROBIT result revealed that watermelon seeds deteriorated at different rate, irrespective of the packaging material in which it is been stored for a period of 180 days. The highest estimate of seed storage-life was obtained with sugar baby seeds that were sun dried then, stored in paper bag (132.7 days). The study concluded that sun drying method was identified as the best seed drying method for the watermelon varieties. Therefore, water melon seeds could be sun dried and then stored in either a paper or polythene bag for the attainment of good physiological quality and extended storability.

Keywords: drying method, seed quality, storage life**,** packaging material, seed storage

Introduction

Watermelon (*Citrullus lanatus* Thunb. Matsum & Nakai) is a tender, warm season vegetable belonging to the family Cucurbitaceae which originated from dry areas of southern Africa (Francis *et al.*, 2019). It is a vine-like flowering plant which grows and matures within a year. Its leaves are coarse, hairy and pinnate lobed with white to yellow flowers. It possesses long, weak, trailing or climbing stems which are five-angled and up to 3m long.

Young growth is densely woolly with yellowish-brown hairs which disappear as the plant ages. It is grown for its edible fruit known as watermelon, which has a smooth hard rind usually green and a juicy, sweet pulp, usually deep red to pink, but sometimes orange, yellow, or white, with many seeds. Watermelon fruit grows on vines with large crinkled leaves (Tabiri *et al*., 2016).

Seed is fundamental to production of crops. After maturation and harvest, seeds have to be stored until required for planting and need to maintain nearly 100% germination (Duffus and Slaughter, 1980, Kehinde *et al.,* 2020). Seed quality can be influenced by environmental factors during seed production, harvesting, processing, packaging, storage and seed treatment (Kehinde *et al.,* 2022).

Drying is an important aspect of seed processing and necessary preservation and the major method of handling produce after harvest (Chong and Lim, 2012). Drying methods influence phytochemical content and antimicrobial activity of plant extracts such as seed (Osinubi *et al*., 2020). It also extends the shelf life of seeds by preserving the quality, reducing microorganism's growth and avoiding certain biochemical reactions that might modify their organoleptic properties (Potisate *et al*., 2014). The mostly employed seed drying methods in Africa countries especially Nigeria include, under shade drying, sun drying and oven drying.

One major problem that besets watermelon seeds is that it deteriorates quickly in storage due to fungal infection (Bankole *et al.,* 2020). The effects of fungal attack on seeds include decreased nutritive value, change in colour, and increase in the peroxide value, reduced seed germination and mycotoxin production (Bankole *et al*., 2020). The moisture content plays a vital role in the maintenance of seed quality in storage. Bankole *et al.,* (2020) reported that a 1% decrease in moisture content doubles the life of seeds. To reduce quality loss in stored products, rapid drying to low moisture is often emphasized, because all factors leading to mould contamination and subsequent damage relate to non-maintenance of stored products at safe moisture content (Bankole *et al.,* 2020). Most African farmers spread their harvests to dry under the sun, which require longer durations for the product to attain 'safe' moisture level. Conditions of high ambient relative humidity particularly during the period of the first season harvest (July to September) often result in extended drying times, which may affect the quality of the product. This often results in dust and foreign matter contamination in the produce with significant losses to rodents and birds. It has been demonstrated that considerable benefit in storage life could be gained by paying attention to seed drying method (Osinubi *et al*., 2020).

Most smallholder farmers use a variety of containers to store their seeds. These include pieces of cloth, black polyethylene bags, galvanized tins, clay pots, and plastic containers, primarily kept under ambient conditions (Kehinde *et al.,* 2022). Furthermore, several studies have shown that the type of storage container can significantly impact the quality of seeds in terms of germination and viability over time (Bortey *et al.,* 2016). It has also been reported that the degree to which seed quality declines under various storage methods varies among different plant species, within the same species, and among different varieties (Adebisi *et al.,* 2019). Therefore, the type and selection of container used for seed storage are critical to maintaining the longevity and viability of the seeds during storage.

The findings of this study would guide poor resource farmers who still depend on farm saved seeds for planting and other seed industries in proper maintenance of seed quality of harvested watermelon seeds. The objectives of this study were to evaluate the effects of seed drying methods and packaging materials on the physiological quality and storability of watermelon seeds and to estimate seed storage life of watermelon seeds.

Materials and Methods

Seed Source: Four varieties of matured watermelon fruits were sourced from an open market at Bodija in Ibadan, Nigeria. Seeds were extracted from each matured fruit by slicing with a knife and scooping out the seeds, cleaned under a running tap and thereafter allowed to dry at room temperature for 36 hours.

Experimental Design: The experiment was a 4 x 4 x 3 factorial experiment in a completely randomized design with 3 replications. There were 48 experimental units consisting of 3 factors namely, variety (sugar baby, kaolak, black diamond and winter king), drying method (sun-drying, oven drying, silica-gel drying, and air-drying) and packaging material (paper bag, polythene bag and plastic container).

Location of the Experiment and Duration

The experiment was carried out in the laboratory of the Department of Plant Breeding and Seed Technology, Federal University of Agriculture, Abeokuta (temperature 27.5°C, RH = 64.7%).

Seed Drying Treatments: The seed samples from the four watermelon varieties were divided into four sub-samples for drying using four different drying methods namely; oven drying, sun drying, air drying (control), and silica gel drying (using Silica Gel Self-indicating Desiccant). Seed samples to be air dried were spread evenly on mesh sieves and placed in rodent proof structures that will allow free air movement while seed samples to be sun dried were placed under direct sun for six hours each day until a constant weight was achieved (Ellis and Roberts, 1991). Seed samples that were dried over silica gel were placed inside porous cloth bags then, placed over activated silica gel at the ratio of 2 seeds:1 silica gel (Ali et al., 2010). For oven drying method, the seeds were dried in an electric oven at 1030C for 17hrs (Rao et al., 2006). The weight of the seed samples was measured before drying and monitored during drying until a constant weight was achieved. The seeds moisture content was calculated using the formula by Rao et al. (2006) and ISTA (1995) thus;

Seed moisture content =

x 100

Seed Storage: 300 g seeds each of the four watermelon varieties were stored using different media after it had been subjected to different drying methods. The packaging materials used were paper bags, polythene bags and 1-litre air tight plastic containers. The seeds were stored for six months (most farmers store seeds for a period of five to six months before the next planting season) and samples were taken every 30 days for seed quality evaluation.

Seed Quality Assessment: Stored seeds were assessed for the following seed quality attributes

i. Seed viability percentage (SVP): 100 seeds from each of the treatment were placed in 90 mm diameter petri-dish on a filter paper moistened with 10 ml water. Seeds were kept inside incubator maintained at 250C and seeds were considered germinated when plumules protruded measured 2mm. Germination progress was monitored for 8 days. Viability percentage was calculated based on the equation according to ISTA (1995).

$$\text{SGP (\%)} = \frac{n8}{N} \times 100$$

Where,

n8= number of seeds germinated at 8 days after sowing

N= total number of seeds sown

ii. Seedling Length (cm): Seedling length was determined from 10 randomly selected normal seedlings from each replicate in each of the treatment.

iii. Mean Germination Time (MGT): This was calculated using the formula by Ellis and Roberts (1980).

$$MGT = \frac{\sum (n_i d_i)}{N}$$

Where,

$\sum$ = summation; n= number of seeds germinated on each day, d = number of days from the beginning of the testN= total number of seeds germinated at the termination of the experiment.

iii. Seedling Vigour Index (SVI): Seedling vigour index value was computed using the formula reported by Kehinde et al. (2022) and expressed as a whole number.

SVI = Germination percentage x Total seedling length

iv. Germination Index (GI): This was recorded using the formula reported by Kehinde et al. (2022):

$$GI = \frac{\sum G_i}{\sum X_i}$$

Where,

Gi = number of seeds germinated each day after sowing

Xi = day of germination count (1, 2…., etc)

Statistical Analyses: Data collected were subjected to analysis of variance (ANOVA) using statistical analytical software (version 9.0, SAS, 2022). Means were separated using Tukey's HSD test at 5% probability level. PROBIT modelling as proposed by Ellis and Robert (1980) and reported by Kehinde *et al.* (2022) was also carried on seed longevity data.

Results

The mean square values of storability attributes evaluated in four watermelon varieties stored for six months in three packaging materials after drying are presented in Table 1. The effects of variety, drying method, packaging material, and variety × drying method × packaging material were highly significant ($p \leq 0.01$) for seed germination index, seed viability and mean germination time of watermelon seed. Seedling length was significantly influenced ($p \leq 0.01$) by drying method, packaging material and variety × drying method × packaging material only. Seedling vigour index was significantly influenced ($p \leq 0.01$) by variety, drying method and packaging material only. However, variety had no significant influence ($p \geq 0.05$) on the seedling length of watermelon seeds. Seedling vigour index of watermelon seed was not significantly influenced ($p \geq 0.05$) by interaction effects among variety, drying method and packaging material. The mean values of the seed physiological attributes of watermelon varieties are presented in Table 2. Black Diamond had the highest seed viability (76.03%) and germination index (9.51) which was statistically similar to that of Sugar Baby (71.22% and 8.91 respectively) and Winter King (69.94% and 8.75 respectively). Meanwhile, Black Diamond and Winter king had the longest seedlings (15.20 cm) that was similar to that of Sugar Baby 13.83 cm) and Kaolak 13.49 cm).

The mean values of the effect of drying methods on seed physiological attributes across watermelon varieties are also presented in Table 2.

There was no significant difference between air drying and silica gel drying methods for all the physiological attributes assessed. Air drying method resulted in the highest watermelon seed germination viability (75.86%) and germination index (9.49) respectively and, shortest mean germination time (0.25 days) which was statistically similar to Sun drying method (73.75%, 9.22 and 0.35 days respectively) and Silica gel drying method (62.42%, 7.80 and 0.41 days respectively).

However, Sun drying method resulted in the longest seedlings (15.54 cm) and maximum seedling vigour index (11.76) respectively which was comparable with only Silica gel drying and air-drying method (15.34 cm 11.25) respectively.

Table 1: Mean square values of storability attributes evaluated in four watermelon varieties stored for six months in three packaging materials after drying

Source of variance	DF	SV (%)	MGT (day)	GI	SL (cm)	SVI
Variety (V)	3	3750.90**	2.89**	58.58**	29.21	113.63**
Drying method (D)	3	2739.00**	5.69**	42.79**	91.14**	75.00**
Packaging Material (P)	2	1552.80**	0.67**	24.24**	146.82**	100.99**
V × D × P	18	506.90**	0.27**	7.92**	35.54**	19.50
Error	96	181.2	0.10	2.83	11.90	11.55

*Significant at 5% probability level, **significant at 1% probability level

DF: degree of freedom, SV: seed viability, MGT: mean germination time, GI: germination index, SL: seedling length, SVI: seedling vigour index

Table 2: Mean performance of the effects of variety, drying method and packaging material on the storability attributes evaluated in four watermelon varieties stored for six months

Treatment	SV (%)	MGT (day)	GI	SL (cm)	SVI
Variety					
Sugar baby	71.22a	0.39bc	8.91a	13.83a	10.17a
Kaolak	52.67b	0.92a	6.59b	13.49a	8.02b
Black diamond	76.03a	0.26c	9.51a	15.20a	11.64a
Winter king	69.94a	0.55b	8.75a	15.20a	11.90a
Mean	67.47	0.53	8.44	14.43	10.43
SE (±)	3.17	0.08	0.40	0.81	0.80
Drying Method					
Sun	73.75a	0.35b	9.22a	15.54a	11.76a
Oven	57.83b	1.12a	7.23b	12.10b	8.49b
Air (control)	75.86a	0.25b	9.49a	14.74a	11.25a
Silica gel	62.42a	0.41b	7.80a	15.34a	10.22ab
Mean	67.47	0.53	8.44	14.43	10.43
SE (±)	3.17	0.08	0.40	0.81	0.80
Packaging Material					
Paper bag	61.35b	0.58a	7.67b	12.63c	8.95b
Polythene bag	72.60a	0.43b	9.08a	16.13a	11.84a
Plastic container	68.44a	0.50b	8.56a	14.53b	10.50ab

Means with the same alphabet along a column are not significantly different from one another at 5% probability level according to Tukey’s HSD Test.

SE: Standard Error, SV: Seed Viability, MGT: Mean Germination Time, GI: Germination Index, SL: Seedling Length, SVI: Seedling Vigour Index

Table 3: Interactive effect among variety, drying method and packaging material on the seed viability and seed germination index of watermelon

Variety	Drying method	Seed viability (%)			Seed Germination Index		
		Paper Bag	Polythene Bag	Plastic Container	Paper Bag	Polythene Bag	Plastic Container
Sugar baby	Sun	91.00a	84.00a-e	45.00a-i	11.38a	10.50a-e	5.63c-j
	Oven	70.70a-e	71.30a-e	73.70a-e	8.84a-e	8.92a-e	9.21b-f
	Air (control)	65.00a-d	91.00a	58.00a-i	8.13a-f	11.38a	7.25b-j
	Silica gel	42.70c-i	76.30a-e	86.00a-d	5.34c-i	9.54a-e	10.75a-e
Kaolak	Sun	76.00a-e	61.70a-g	76.00a-e	9.50a-e	7.71a-g	9.50b-f
	Oven	13.70i	40.00e-i	16.30hi	1.71i	5.00e-i	2.05ij
	Air (control)	84.70a-e	60.30a-h	69.30a-e	10.59a-e	7.54a-h	8.67b-f
	Silica gel	20.00f-i	62.00a-f	52.00a-i	2.50f-i	7.75a-f	6.50b-j
Black diamond	Sun	76.00a-e	73.70a-e	64.00a-f	9.50a-e	9.21a-e	8.00b-g
	Oven	82.00a-e	89.00ab	87.00abc	10.25a-e	11.13ab	10.88bcd
	Air (control)	88.30ab	83.70a-e	74.00a-e	11.04ab	10.46a-e	9.25b-f
	Silica gel	53.10a-i	69.00a-e	72.00a-e	6.71a-i	8.63a-e	9.00a-f
Winter king	Sun	69.30a-e	83.30a-e	85.00a-e	8.67a-e	10.42a-e	10.63b-f
	Oven	16.70ghi	55.70a-i	78.00a-e	2.09ghi	6.96a-i	9.75b-f
	Air (control)	90.70a	69.70a-e	75.70a-e	11.34a	8.71a-e	9.46b-f
	Silica gel	41.30d-i	91.00a	83.00a-e	5.17d-i	11.38a	10.38b-f

Means with the same alphabet among columns of storability attributes are not significantly different from one another at 5% probability level according to Tukey's HSD Test.

4: Interactive effect among variety, drying method and packaging material on the mean germination time and seedling length of watermelon

Variety	Drying method	Mean Germination Time (day)			Seedling Length (cm)		
		Paper Bag	Polythene Bag	Plastic Container	Paper Bag	Polythene Bag	Plastic Container
Sugar baby	Sun	0.18b	0.19b	0.71b	15.66a-d	13.60a-e	5.90j
	Oven	0.23b	0.75b	0.38b	8.87b-j	15.77abc	11.87a-h
	Air (control)	0.37b	0.18b	0.14b	10.49a-i	13.70a-e	2.97g-j
	Silica gel	0.89b	0.39b	0.32b	5.65e-j	17.57ab	11.58a-i
Kaolak	Sun	0.39b	0.43b	0.40b	11.37a-i	10.57a-f	11.00a-i
	Oven	2.70a	2.07a	2.90a	0.29j	18.00ab	0.26j
	Air (control)	0.13b	0.43b	0.23b	13.35a-g	19.40ab	12.05a-h
	Silica gel	0.56b	0.26b	0.49b	2.34hij	18.03ab	9.00b-j
Black diamond	Sun	0.40b	0.28b	0.37b	13.96a-f	16.10abc	9.69b-j
	Oven	0.19b	0.18b	0.18b	10.88a-i	16.03abc	14.17a-f
	Air (control)	0.24b	0.10b	0.15b	14.41a-e	10.77a-f	11.21a-i
	Silica gel	0.72b	0.18b	0.12b	6.78c-j	18.73ab	10.31a-i
Winter king	Sun	0.44b	0.26b	0.12b	12.19a-h	21.47a	13.26a-f
	Oven	2.28a	0.68b	0.87b	0.84ij	12.30a-f	13.86a-f
	Air (control)	0.35b	0.35b	0.30b	12.91a-g	15.30a-d	12.98a-f
	Silica gel	0.52b	0.18b	0.29b	3.24f-j	20.70a	17.93ab

Means with the same alphabet along the column are not significantly different from one another at 5% probability level according to Tukey's HSD test.

The mean values of the effect of packaging materials on storability attributes across dried watermelon varieties stored for six months are also presented in Table 2. There was no significant difference between air drying and silica gel drying methods for all the physiological attributes assessed. Silica gel drying method resulted in the highest watermelon seed viability (95.3%) and germination index (11.92) and, shortest mean germination time (0.39 days) which was statistically similar to air drying method (91.8%, 11.47 and 0.64 days respectively) and sun drying method (89.8%, 11.22 and 0.87 days respectively). However, silica gel drying method resulted in the longest seedlings (14.43 cm) and maximum seedling vigour index (13.76) that was comparable with only air-drying method (12.94 cm and 11.9).

Table 3 shows that silica gel dried Winter King seeds that were stored in polythene bags, sun dried Sugar baby seeds that were stored in paper bags and air-dried Sugar Baby seeds that were stored in polythene bags had the highest seed viability (91%). Meanwhile, sun dried Sugar Baby that were stored in paper bags and silica gel dried Winter King seeds that were stored in polythene bags had the highest seed germination index (11.38).

Air dried Black Diamond seeds that were stored in polythene bags had the lowest mean germination time (0.10 day) and, sun dried Winter King seeds that were stored in polythene bags had the longest seedlings (21.47 cm) (Table 4).

Probit analysis of seed viability data (Table 5) was used to estimate of the probit value of initial seed viability at the time of storage, the rate of seed physiological deterioration, the time taken to lose 1 probit seed viability, the time taken for a seed lot to lose 50% viability and absolute seed longevity.

Sun-dried Paper bag-stored seeds of sugar Baby had the highest seed storage life of approximately 132 days compared to other watermelon varieties considered. Sugar baby seeds that were sun dried then stored in plastic container had the lowest rate of deterioration (-0.035) and the highest rate (-0.214) was recorded by Black Diamond seeds that were air dried then stored in plastic container or polythene bag (Table 5).

Discussion

Drying plays a crucial role in maintaining seed quality by ensuring adequate airflow and removing excess moisture from the seed surface, thereby preventing deterioration during storage. (Bankole *et al.*, 2020). In this study, the findings revealed that drying methods significantly influenced all the physiological attributes evaluated. Notably, the interaction between drying method and watermelon variety was highly significant for germination percentage, germination index, and seedling vigour index. Six months after storage, oven-dried seeds exhibited the lowest germination percentage (69.8%) and germination index (65.2), closely followed by seeds dried using silica gel (73.1% and 70.4, respectively). In contrast, sun drying and air drying resulted in significantly higher germi-nation percentages (85.4% and 86.3%, respectively) and germination indices (81.8 and 83.9, respectively). These results align with the findings of Somado *et al.* (2006), who reported that sun drying effectively preserved the germination potential of rice seeds by maintaining moisture content at an optimal level. Similarly, Patra *et al.* (2016) found that shade drying and sun drying were preferable for preserving seed quality, this further supports the beneficial effects of natural drying methods over artificial ones. After six months of storage, oven-dried seeds consistently exhibited the poorest seed quality, with the lowest germination percentage, seedling vigor index, and mean germination time. This suggests that prolonged exposure to high temperatures negatively affects seed longevity and viability. Conversely, seeds dried using sun drying, silica gel, and air drying maintained desirable physiological character-ristics, making them more suitable for long-term storage. These findings corroborate the work of Ellis and Hong (2007), who reported that extreme drying conditions, particularly those involving high temperatures, can accelerate seed aging and reduce viability over extended storage periods.

Table 5: Results of probit modelling of seed viability data in four watermelon varieties after drying and storage in packaging materials for six months.

Variety	Drying Method	Packaging Material	Intercept	Slope	Sigma	%P_{50}	Seed Storage life
Sugar baby	Sun	Paper Bag	1.283	-0.064	1552.5	1991.2	132.7
		Polythene	0.164	-0.037	2681.2	440.2	29.3
		Plastic	0.015	-0.035	1933.0	1312.2	87.5
	Oven	Paper Bag	0.749	-0.044	2258.7	1692.6	112.8
		Polythene	1.813	-0.104	964.4	1748.5	116.6
		Plastic	1.708	-0.094	1061.5	1813.9	120.9
	Air	Paper Bag	0.623	-0.041	2401.3	1498.4	99.9
		Polythene	1.466	-0.075	1324.1	1941.2	129.4
		Plastic	0.565	-0.041	2461.0	1389.9	46.3
	Silica gel	Paper Bag	1.339	-0.068	1479.7	1981.7	132.1
		Polythene	1.709	-0.094	1061.5	1813.9	120.9
		Plastic	2.477	-0.179	559.5	1385.6	92.4
Kaolak	Sun	Paper Bag	2.090	-0.133	751.1	1569.7	104.6
		Polythene	1.400	-0.071	1403.7	1965.2	131.0
		Plastic	2.476	-0.179	559.5	1385.6	92.4
	Oven	Paper Bag	-0.366	-0.043	2336.9	856.4	57.1
		Polythene	-0.647	-0.053	1879.7	1216.2	81.1
		Plastic	-0.502	-0.047	2135.1	1072.4	71.5
	Air	Paper Bag	0.064	-0.037	2674.5	170.7	11.4
		Polythene	1.538	-0.081	1240.8	1908.7	127.2
		Plastic	2.477	-0.179	559.5	1385.6	92.4
	Silica gel	Paper Bag	-0.237	-0.040	2490.0	589.3	39.3
		Polythene	0.654	-0.042	2368.6	1549.9	103.3
		Plastic	1.538	-0.081	1240.8	1908.7	127.2
Black diamond	Sun	Paper Bag	-0.393	-0.043	2300.6	904.3	60.3
		Polythene	2.477	-0.179	559.5	1385.6	92.4
		Plastic	1.937	-0.116	861.4	1668.3	111.2
	Oven	Paper Bag	1.538	-0.081	1240.8	1908.7	127.2
		Polythene	2.477	-0.179	559.5	1385.6	92.4
		Plastic	-0.236	-0.040	2490.0	589.3	39.3
	Air	Paper Bag	1.400	-0.071	1403.6	1965.2	131.0
		Polythene	2.753	-0.214	466.2	1283.5	85.6
		Plastic	2.753	-0.214	466.2	1283.5	85.6
	Silica gel	Paper Bag	1.813	-0.103	964.4	1748.5	116.6
		Polythene	1.937	-0.116	861.3	1668.2	111.2
		Plastic	0.624	-0.042	2401.3	1498.4	99.9
Winter king	Sun	Paper Bag	0.139	-0.037	2681.9	372.4	24.8
		Polythene	1.403	-0.087	1154.7	1619.8	107.9
		Plastic	2.090	-0.133	751.1	1569.7	104.6
	Oven	Paper Bag	0.925	-0.049	2034.4	1880.9	125.4
		Polythene	1.044	-0.053	1872.9	1955.3	130.4
		Plastic	0.015	-0.035	1933.0	1312.2	87.5
	Air	Paper Bag	0.164	-0.037	2681.0	439.8	29.3
		Polythene	1.937	-0.116	861.3	1668.2	111.2
		Plastic	1.708	-0.094	1061.5	1813.9	120.9
	Silica gel	Paper Bag	2.753	-0.214	466.2	1283.5	85.6
		Polythene	1.466	-0.076	1324.1	1941.1	129.4
		Plastic	0.565	-0.041	2461.0	1389.9	46.3

*Intercept is PROBIT estimate of initial seed viability
**slope is the rate of seed deterioration
***Sigma is time taken for seed lot to lose one probit viability
% P50 is seed half- life in days
Seed storage life was estimated as %P50 value multiplied by 2 then divided by the 30 days of a month

Probit modeling was employed to predict the storage life of watermelon seeds in this study, an approach previously utilized by Kehinde *et al.* (2020) and Adebisi *et al.* (2019) to estimate seed longevity across various species. The results of the probit model revealed that watermelon seeds deteriorated at varying rates irrespective of the packaging material used over the 180 days storage period. Sugar baby seeds that were sun-dried and subsequently stored in plastic containers exhibited the lowest deterioration rate (-0.035), whereas Black Diamond seeds that were air-dried and stored in plastic containers or polythene bags recorded the highest deterioration rate (-0.214). The highest estimated seed shelf-life (132.7 days) was recorded for sugar baby seeds that were sun-dried and stored in paper bags. In contrast, Kaolak seeds that were air-dried and stored in paper bags exhibited the shortest storage life. Overall, sugar baby seeds stored in paper bags following sun drying or silica gel application demonstrated the highest storage longevity, maintaining viability for approximately 132 days, whereas other watermelon varieties exhibited reduced seed longevity over the six-month (180 days) storage period.

The significant effect of packaging materials and drying methods on all seed quality parameters, except for the rate of germination, indicates that variations in seed performance were largely influenced by storage duration. Additionally, the observed significant effects of variety, drying method, and packaging material on seed germination rate suggest that the rate of germination was dependent on the specific packaging materials used. This observation supports the earlier findings of Kehinde *et al.* (2020), who reported a strong influence of packaging material on the seed quality of watermelon.

In conclusion, the optimum drying method for improved seed viability and seedling vigour index traits of watermelon seeds after storing in packaging materials for six months is sun drying method with a seed viability rate of 73.75% and, seedling vigour index of 11.76. Packaging materials significantly influenced the storability of watermelon seeds. The use of paper bags as a packaging material resulted in a higher seed storage life (approximately 133 days) for watermelon seeds (most especially for sun dried sugar baby seeds). The seeds of sugar baby variety that is sun dried and then stored in a paper bag is recommended to achieve desirable physiological quality and extended storability of watermelon seeds.

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