Journal of Advances in Biology & Biotechnology

Volume 27, Issue 7, Page 1159-1167, 2024; Article no.JABB.119310
ISSN: 2394-1081

Evaluation of Physiological and Biochemical Parameters of Onion Seed as Influenced by Different Packaging Materials and Storage Conditions

Islavath Suresh Naik [a++*], J.S. Hilli [b#], D.S. Uppar [a†], Ramangouda V. Patil [c‡] and C.M. Nawalagatti [d‡]

[a] Department of Seed Science and Technology, UAS, Dharwad, 580005, India.
[b] College of Agriculture, Hanumanmatti, 581115, India.
[c] Department of Horticulture, College of Agriculture, UAS, Dharwad, 580005, India.
[d] Department of Crop Physiology, College of Agriculture, UAS, Dharwad, 580005, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jabb/2024/v27i71075

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/119310

Original Research Article

Received: 24/04/2024
Accepted: 26/06/2024
Published: 27/06/2024

ABSTRACT

A lab experiment was conducted for 18 months of the period to study the seed physiological and biochemical parameters like moisture content and electrical conductivity respectively. How the different packaging materials and storage conditions influenced the moisture content and electrical

[++] P.h D Scholar;
[#] Dean;
[†] Professor and Head;
[‡] Professor;
**Corresponding author: E-mail: islavathsureshnaik@gmail.com;*

Cite as: *Naik, Islavath Suresh, J.S. Hilli, D.S. Uppar, Ramangouda V. Patil, and C.M. Nawalagatti. 2024. "Evaluation of Physiological and Biochemical Parameters of Onion Seed As Influenced by Different Packaging Materials and Storage Conditions". Journal of Advances in Biology & Biotechnology 27 (7):1159-67. https://doi.org/10.9734/jabb/2024/v27i71075.*

conductivity were evaluated. Onion seeds were evaluated at bi-monthly intervals, and the experimental design followed was a factorial completely randomized design (FCRD) with 3 replications and 2 factors, namely storage conditions such as ambient and cold storage and storage containers (cloth bag, high-density polythene bag (HDPE), polythene bag (700 gauge), aluminum laminated bag, vacuum packed bag), the results revealed that the seeds stored in the vacuum packed bag along with combination of cold storage gave good results at the end of 18 months of storage period i.e., seed moisture content (6.95 %) and electrical conductivity (0.732 dSm-1) respectively compared to other treatments. Next to the vacuum-packed bag with cold storage, the best results were seen in the treatment in which Onion seeds were stored in cold storage with the aluminum laminated bag.

Keywords: Vacuum-packed bag; high-density polythene bag; cold storage; ambient storage; moisture content; electrical conductivity.

1. INTRODUCTION

Onion (*Allium cepa* L.) is one of the major bulb crops grown in the world. It holds a significant place in the world due to its widespread cultivation area and high demand for its consumption. Most of the onion produced in India comes from Maharastra, Karnataka, Uttar Pradesh Orissa, and Gujarath, [1]. It is generally known that seeds rapidly lose their viability after harvest unless special precautions are taken in their storage [2-5]. The seed possesses the highest vigor at the time of physiological maturity and gradually decreases as the storage period increases (Goel et al*.,* 2003). The percentage and rate of germination of onion seeds also vary considerably among seed lots and this leads to difficulties in establishing optimum plant populations in the field. It has long been known that the factors, that have the greatest influence on the longevity of seeds in storage, are moisture, temperature, and oxygen partial pressure [6]. Maintaining seed viability for a longer period is very essential to preserve the genetic integrity of stored samples. Storage temperature and moisture content are the most important factors affecting seed longevity, with seed moisture content usually being more influential than temperature. The ability of seeds to germinate decreases as catabolic changes occur with age [7].

Majorly the initial quality of seeds, moisture level, relative humidity (RH %), and storage conditions have considerable influence on seed storage. However, if the seeds are stored in controlled conditions, it is suitable for maintenance of the seed quality for a longer duration. Relative humidity plays a major role during storage. If the relative humidity is higher then seeds can absorb more moisture leading to deterioration. Supplying high-quality seeds can be achieved by an appropriate post-harvest storage technology [8].

Seeds are harmed by moisture and higher storage temperatures. Ellis et al., [9] The present investigation has been carried out to find out the effect of different storage containers and storage environments on the seed physiological and biochemical parameters respectively.

2. MATERIALS AND METHODS

At the NSP, Seed unit, UAS, Dharwad, a lab experiment was conducted from April 2021 to September 2022. The seed physiological and biochemical parameters such as moisture content and electrical conductivity respectively were assessed, and the experiment design used was a factorial completely randomized design (FCRD) with 3 replications and 2 factors, namely storage conditions such as ambient and cold storage and storage containers such as cloth bags, high-density polythene bags (HDPE), polythene bags, aluminum laminated bags and vacuum-packed bags. Statistical analysis was done with OP stat and results were expressed. The seeds were stored for 18 months. Arka Kalyan variety was used for the study. The seed is purchased from the University of Horticultural Sciences, Bagalkot. Every bi-monthly, readings were taken.

2.1 Seed Moisture (%)

The test was conducted with independently drawn five grams working sample powder (Anon., 2013). The weight of the cup in grams along with the lid was taken (M_1), and then five grams of coarse ground seed material was added to the cup (M_2). The samples were incubated in a hot air oven at 103 °C for 24 hours. After the completion of the drying period, the moisture cups were removed and kept in the desiccator for 15-20 minutes and then the weight was taken (M_3).

$$\text{Seed moisture (\%)} = \frac{(M_2 - M_3)}{(M_2 - M_1)} \times 100$$

Where,

M_1: Weight (g) of the moisture cup + lid

M_2: Weight (g) of the moisture cup + lid + sample before drying

M_3: Weight (g) of the moisture cup + lid + sample after drying

2.2 Electrical Conductivity of Seed Leachate (dS m^{-1})

All seeds were thoroughly washed in distilled water. Then, the seeds were soaked in 25 ml distilled water and kept in incubation at room temperature for twelve hours. The seed leachate was collected and the volume was made up to 25 ml by adding distilled water. The electrical conductivity of the seed leachate was measured with the digital conductivity bridge (ELICO) with a cell constant of 1.0 and the mean values were expressed in deci-Simons per meter (dS m^{-1}) [10].

3. RESULTS AND DISCUSSION

There was a significant effect of storage containers and duration under ambient and cold temperatures on moisture content and electrical conductivity was given in Tables 1 to 2.

3.1 Moisture Content

The results of moisture content, as influenced by storage conditions, packaging materials, and their interactions during the storage period are given in Table 1. The percent increase in moisture content in the treatment combinations during the storage period was expressed in Fig. 1. With the increase in storage period, increase in moisture percent from 6.81 at the 2nd month to 7.82 percent at the end of the 18th month of the storage period irrespective of storage conditions and packaging materials.

3.1.1 Storage conditions (S)

Regardless of initial storage conditions and their packaging material higher mean moisture was noticed in ambient storage compared to cold storage throughout the storage period (18 months). The increase in mean moisture was from 6.82 to 8.27 percent and from 6.78 to 7.35 percent in ambient storage and cold storage respectively.

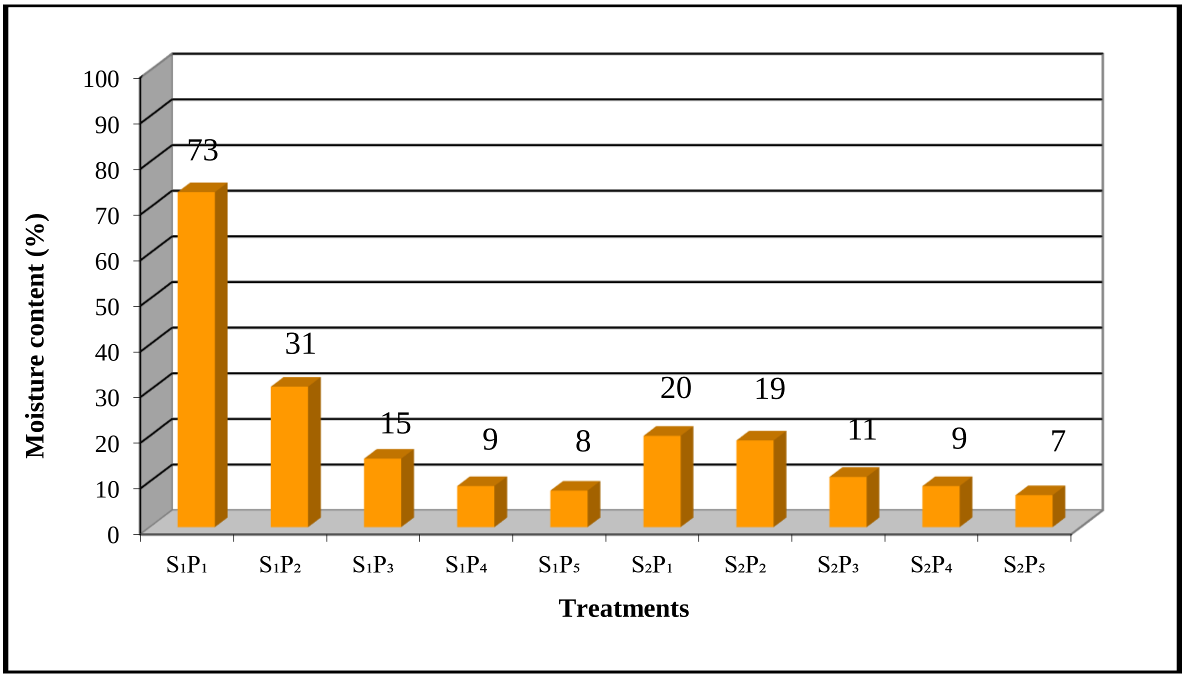

Fig. 1. Percent increase in the moisture content of treatment interactions after 18 months of storage

Table 1. Influence of packaging material and storage conditions on seed moisture content (%) during storage in onion seeds

Treatments	**Storage (Months)**								
	2	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**
Storage conditions (S)									
S_1: Ambient	6.82	6.94	7.04	7.16	7.33	7.52	7.74	7.92	8.27
S_2: Cold	6.78	6.82	6.87	6.92	7.02	7.06	7.12	7.24	7.35
S. Em (±)	0.004	0.015	0.008	0.007	0.02	0.02	0.02	0.008	0.02
C. D. (1%)	0.017	0.065	0.035	0.030	0.10	0.09	0.11	0.036	0.08
Packaging materials (P)									
P_1: Cloth bag	7.00	7.20	7.37	7.54	7.89	8.20	8.65	8.90	9.54
P_2: High density polythene bag	6.85	6.99	7.10	7.27	7.48	7.63	7.77	7.90	8.12
P_3: Polythene bags (700 gauge)	6.76	6.79	6.83	6.87	6.96	7.00	7.10	7.23	7.35
P_4: Aluminum laminated pouch	6.73	6.74	6.77	6.81	6.82	6.83	6.85	6.98	7.08
P_5: Vacuum packed bags	6.67	6.68	6.71	6.73	6.76	6.79	6.80	6.90	6.97
S. Em (±)	0.006	0.024	0.013	0.011	0.03	0.03	0.04	0.01	0.03
C. D. (1%)	0.027	0.103	0.056	0.048	0.16	0.15	0.17	0.05	0.14
Interaction (S x P)									
S_1P_1	7.02	7.35	7.61	7.88	8.42	8.95	9.73	10.12	11.27
S_1P_2	6.89	7.11	7.21	7.43	7.62	7.87	8.05	8.18	8.50
S_1P_3	6.77	6.80	6.87	6.92	7.03	7.13	7.27	7.38	7.50
S_1P_4	6.74	6.76	6.79	6.84	6.85	6.86	6.88	7.00	7.11
S_1P_5	6.69	6.71	6.73	6.75	6.77	6.80	6.81	6.93	7.00
S_2P_1	6.99	7.07	7.13	7.20	7.36	7.45	7.58	7.70	7.82
S_2P_2	6.82	6.88	7.00	7.11	7.34	7.40	7.49	7.62	7.75
S_2P_3	6.76	6.78	6.81	6.83	6.90	6.88	6.93	7.08	7.20
S_2P_4	6.72	6.73	6.75	6.78	6.79	6.81	6.82	6.97	7.07
S_2P_5	6.65	6.66	6.69	6.72	6.75	6.78	6.79	6.87	6.95
Mean	**6.81**	**6.88**	**6.96**	**7.05**	**7.18**	**7.29**	**7.44**	**7.58**	**7.82**
S. Em (±)	**0.009**	**0.030**	**0.019**	**0.016**	**0.05**	**0.05**	**0.05**	**0.01**	**0.04**
C. D. (1%)	**0.038**	**0.14**	**0.080**	**0.069**	**0.22**	**0.21**	**0.24**	**0.08**	**0.19**
C.V (%)	**0.24**	**0.88**	**0.48**	**0.41**	**1.31**	**1.24**	**1.39**	**0.45**	**1.05**

NS: Non-significant, Storage conditions (S): S1: Ambient Storage, S2: Cold Storage, Packaging Materials (P): P1: Cloth Bag, P2: High Density Polythene Bag, P3: Polythene Bags (700 gauge), P4: Aluminum Laminated Pouch, P5: Vacuum Packed Bags (Initial=6.50 %)

Table 2. Influence of packaging material and storage conditions on electrical conductivity (dSm^{-1}) of seed leachates during storage in onion seeds

Treatments	Storage (Months)								
	2	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**
Storage Conditions (S)									
S_1: Ambient	0.744	0.747	0.757	0.770	0.804	0.860	0.905	0.960	1.064
S_2: Cold	0.691	0.693	0.697	0.704	0.713	0.721	0.729	0.743	0.758
S. Em (±)	0.0002	0.0002	0.002	0.0003	0.001	0.002	0.001	0.002	0.004
C. D. (1%)	0.0008	0.001	0.009	0.001	0.006	0.010	0.007	0.011	0.020
Packaging Materials (P)									
P_1: Cloth bag	0.726	0.728	0.747	0.770	0.821	0.926	1.00	1.090	1.220
P_2: High density polythene bag	0.722	0.725	0.728	0.736	0.755	0.778	0.799	0.838	0.939
P_3: Polythene bags (700 gauge)	0.717	0.720	0.723	0.729	0.749	0.764	0.779	0.799	0.816
P_4: Aluminum laminated pouch	0.712	0.715	0.719	0.725	0.736	0.743	0.754	0.770	0.797
P_5: Vacuum packed bags	0.710	0.712	0.716	0.724	0.732	0.739	0.747	0.756	0.774
S. Em (±)	0.0003	0.0004	0.003	0.0005	0.002	0.003	0.002	0.004	0.007
C. D. (1%)	0.001	0.001	0.015	0.002	0.010	0.016	0.010	0.018	0.032
Interaction (S x P)									
S_1P_1	0.755	0.759	0.793	0.828	0.922	1.123	1.270	1.423	1.677
S_1P_2	0.749	0.753	0.756	0.763	0.791	0.832	0.865	0.925	1.107
S_1P_3	0.743	0.746	0.749	0.753	0.785	0.805	0.827	0.853	0.870
S_1P_4	0.739	0.741	0.745	0.754	0.762	0.770	0.783	0.805	0.850
S_1P_5	0.736	0.739	0.742	0.754	0.762	0.771	0.780	0.794	0.817
S_2P_1	0.697	0.699	0.702	0.713	0.721	0.730	0.740	0.765	0.780
S_2P_2	0.695	0.697	0.701	0.709	0.720	0.726	0.733	0.752	0.772
S_2P_3	0.693	0.695	0.697	0.706	0.714	0.723	0.732	0.745	0.763
S_2P_4	0.687	0.690	0.694	0.698	0.710	0.717	0.726	0.737	0.745
S_2P_5	0.685	0.687	0.691	0.696	0.703	0.709	0.714	0.765	0.732
Mean	**0.72**	**0.72**	**0.72**	**0.74**	**0.76**	**0.79**	**0.82**	**0.85**	**0.91**
S. Em (±)	**0.0004**	**0.0006**	**0.005**	**0.0007**	**0.003**	**0.005**	**0.004**	**0.006**	**0.011**
C. D. (1%)	**0.001**	**0.002**	**0.021**	**0.003**	**0.014**	**0.023**	**0.017**	**0.026**	**0.046**
C.V (%)	**0.11**	**0.16**	**1.25**	**0.18**	**0.82**	**1.21**	**0.87**	**1.29**	**2.12**

NS: Non-Significant, Storage Conditions (S): S1: Ambient storage, S2: Cold Storage, Packaging Materials (P): P1: Cloth Bag, P2: High density Polythene Bag, P3: Polythene Bags (700 gauge), P4: Aluminum Laminated Pouch, P5: Vacuum Packed Bags (Initial=0.670 dSm^{-1})

3.1.2 Packaging materials (P)

Among all the packaging materials, a higher mean moisture increase was noticed in cloth bags followed by HDPE bags, polythene bags, aluminum laminated pouches, and vacuum-packed bags. Mean moisture content increased from 7.00 to 9.54 percent in cloth bags and from 6.67 to 6.97 percent in vacuum-packed bags through the storage period.

3.1.3 Interaction (S x P)

The interaction effect of storage conditions and packaging material on mean moisture was found to be significant throughout the storage period. Among all the treatments, combinations S_2P_5 reported significantly lowest moisture of 6.95 percent at the end of the storage period. S_1P_1 recorded significantly the highest moisture of 11.27 percent at the end of the 18 months storage period. There was a 73 percent increase in moisture content in S_1P_1 followed by S_1P_2, (31 %), and a 7 percent increase was seen in S_2P_5. Moisture content increased as the storage progressed. The highest increase was seen in treatment S_1P_1 (73 %) then followed by S_1P_2 (31 %) and the lowest increase was seen in S_2P_5 (7 %).

3.2 Electrical Conductivity

The results of electrical conductivity as influenced by storage conditions, packaging materials, and their interactions during the storage period are given in Table 2. With the increase in storage period, increase in electrical conductivity from 0.720 in the 2nd month to 0.910 dSm^{-1} at the end of the 18th month of the storage period irrespective of storage conditions and packaging materials.

3.2.1 Storage conditions (S)

Regardless of initial storage conditions and their packaging material higher mean electrical conductivity was noticed in ambient storage compared to cold storage throughout the storage period (18 months). The increase in mean electrical conductivity was from 0.744 to 1.064 dSm^{-1} and from 0.691 to 0.758 dSm^{-1} in ambient storage and cold storage respectively.

3.2.2 Packaging materials (P)

Among all the packaging materials, a higher mean electrical conductivity increase was noticed in cloth bags followed by HDPE bags, polythene bags, aluminum laminated pouches, and vacuum-packed bags. Mean electrical conductivity increased from 0.726 to 1.220 dSm^{-1} in cloth bags and from 0.710 to 0.774 dSm^{-1} in vacuum-packed bags throughout the storage period.

3.2.3 Interaction (S x P)

The interaction effect of storage conditions and packaging material on mean electrical conductivity was found to be significant throughout the storage period. Among all the treatments, combinations S_2P_5 reported significantly the lowest electrical conductivity of 0.732 dSm^{-1} at the end of the storage period, while S_1P_1 recorded significantly the highest electrical conductivity of 1.677 dSm^{-1} at the end of the 18-month storage period.

In the present study, there was a lot of fluctuation in the seed moisture content stored in cloth bags and HDPE bags, and in ambient conditions as compared to cold conditions, less moisture was seen in aluminum laminated pouches and vacuum-packed bags. Seeds absorbed moisture when relative humidity (RH) was high whereas, they lost the moisture when humidity was low. The differential moisture content was due to surrounding environmental conditions and the hygroscopic nature of the seeds. Similar results were also reported by Shelar et al. [11] in onion, Jaya et al. [12] in soybean, Sarma et al. [13] in cowpea, Veraja and Rai [14] in blackgram, Gnyandev et al. [15] in chickpea, Amruta et al. [16] in blackgram, Shankar et al. [17] in blackgram, Tandoh et al. [18] in seeds of *Pericopsis elata* and Kumar et al. [19] in alfalfa.

Similarly, when seeds were stored in previous packaging materials like cloth bags, HDPE bags and kept in cold conditions, all the seeds absorbed the moisture. The sample of polythene bags used for the vacuum package was checked for its water transmission rate and Oxygen transmission rate. As vacuum polythene bag had very less water vapour transmission rate (WTR) (0.95 $g/m^2/24$ hrs at 30ºC and 90.0 % RH), oxygen transmission rate (OTR) [0.91 cc/ ($m^2 \times$ day $\times$ atm)] and higher thickness (149.40 microns). Due to these special characteristics of the polythene bag that was used for vacuum packaging, there was very little variation in the moisture content of the seeds throughout the storage period both in cold and ambient storage conditions. These results are in accordance with Khanna et al. [20] in chickpeas, Meena et al. [21] in soybean, and Deepa et al. [22] in chilli.

The Electrical conductivity **(**EC) of seed leachate is the index of vigor, seed viability, and deterioration. Generally, higher values of EC indicate a higher rate of seed deterioration as they are positively correlated, whereas, leaching of sugars and amino acids from seed membranes is negatively associated with membrane integrity, germination, and vigor.

In the present study, as the storage period progressed, the electrical conductivity of seed leachate was increased and higher values of EC were recorded in cloth bags and HDPE bags in both ambient and cold conditions. However, it was more in ambient condition as compared to the cold storage condition as there was a higher rate of seed deterioration. Due to the lower rate of seed deterioration in vacuum-packed bags, the lower EC was recorded, irrespective of storage conditions. At the end of the storage period, higher EC was recorded in cloth bags and HDPE bags and these treatments were significantly different with vacuum-packed bags stored in both conditions. These results were similar to the pattern reported by Malimath and Merwade, [23] in garden peas, Amruta et al. [16] in black gram, Narayanaswamy [24] in groundnut, Gnyandev et al. [15] in chickpeas, Shelar et al. [11] in soybean, and Kumar et al. [19] in Alfalfa.

The causes for the increase in the EC of seeds is due to loss of cell membrane integrity with the advancement in the storage period as membrane integrity of the seed has a greater influence on seed performance. Similarly, the negative relationship between EC and seed germination indicated low-quality seed and lowered germination capacity [25,26].

4. CONCLUSION

It was concluded that different storage conditions and storage containers play a significant role in the moisture content and electrical conductivity of onion seeds. Moisture content and electrical conductivity of the onion seeds were increased as the storage progressed but at a lesser pace in the vacuum-packed bags stored in a cold storage environment compared to other treatment combinations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Barakade AJ, Lokhande TN, Todkari GU. Economics of onion cultivation and its marketing pattern in Satara district of Maharashtra. International Journal of Agriculture Sciences. 2011;3(3):110-117.
2. Adam, Olosunde, Ojo Abisoye, Uthman Tolani, Olasoji Julius, Oluwadare Ayooluwa, and Aliyu Taiwo. Germination performance and vigour of pepper seeds stored in different environmental conditions at different Storage Periods. Asian Journal of Biology. 2018;5(2):1-6.
Available:https://doi.org/10.9734/AJOB/2018/39791
3. Aculey P, Tandoh PK, Gamenyah DD. Physiological seed quality responses of three rice varieties to different storage materials under ambient conditions. Journal of Experimental Agriculture International. 2023;45(9):135-41.
Available:https://doi.org/10.9734/jeai/2023/v45i92184.
4. Kibar H, Yücesan B. Effects of storage durations at different temperatures on various physiological parameters of einkorn seed (*Triticum monucocum* L.) germination. Journal of Stored Products Research. 2021;93:101851.
5. Ludwig V, Berghetti MR, Rossato FP, Wendt LM, Schultz EE, Both V, Brackmann A. Impact of controlled atmosphere storage on physiological quality of soybean seed. Journal of Stored Products Research. 2021;90:101749.
6. Amjad M, Anjum MA. Evaluation of physiological quality of onion seed stored for different periods. International Journal of Agriculture and Biology. 2002;4(3):365-369.

7. Rao D, Pashwan VR, Chaitanya G, Verma B, Negi PS, et al. Physiological and biochemical changes during seed deterioration in seed –A Review. Deepak Rao., ELSJ. 2023;9(1):1–10.
8. Shivappa R. Studies on the effect of modified atmospheric storage condition on storability of onion seeds. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Raichur, Karnataka; 2011.
9. Ellis RH, Roberts EH. The quantification of aging and survival in orthodox seeds. Seed Science and Technology. 1981; 9:373-409.
10. Presley JT. Relationship of protoplast permeability of cotton seed viability and predisposition of seedling disease. Plant Disease Reporter. 1958;42(7): 582.
11. Shelar VR, Mali MS, Nagawade DR. Influence of storage conditions on quality of soybean [*Glycine max* (l.) Merill] Seeds. Journal of Food Legumes. 2015;28(2):165-169.
12. Jaya J, Wani AA, Titov A, Tomar DS. Seed quality parameters of soybean (*Glycine Max*. L.) as influenced by seed treating fungicides and botanicals and packing materials. Indian Journal of Applied Research. 2014;3(4):219-222.
13. Sarma AK, Devi MR, Nigam A. Efficiency of storage device for long-term storage of cowpea seeds. International Journal of Agriculture Environment and Biotechnology. 2014;7(2):233-240.
14. Veraja P and Rai PK. Effect of polymer coating, chemicals, and biocontrol agent on storability of black gram (*Vigna mungo* L.). International Journal of Plant and Soil Science. 2015;8(6):1-8.
15. Gnyandev B, Kurdikeri MB, Salimath PM, Ravinderkumar, Kailashnath. Influence of seed size on storage potential of chickpea varieties. International Journal of Agricultural Sciences Research. 2015; 5(4):189-194.
16. Amruta N, Sarika G, Umesha JB, Maruthi, Basavaraju GV. Effect of botanicals and insecticides seed treatment and containers on seed longevity of black gram under natural aging conditions. Journal of Applied and Natural Science. 2015;7(1): 328-334.
17. Shankar S V, Pandiarajanb T and Ganapathy S, 2018, Biochemical changes of black gram grains during hermetic storage. Research Journal of Chemical and Environmental Sciences, 6(6): 15-21.
18. Tandoh PK, Banful B, Gaveh E, James O, Amponsah. Effects of packaging materials and storage periods on seed quality and longevity dynamics of *Pericopsis elata* seeds. Environment, Earth and Ecology. 2017;1(2):27-38.
19. Kumar PA, Channakeshava BC, Siddaraju R. Influence of seed treatments and packaging materials on seed longevity of alfalfa (*Medicago Sativa* L.) CV. RL-88. Plant Archives. 2017;17(2):1221-1227.
20. Khanna N, Jain P, Teckchandani CK. Comparative study of quality and nutritive parameters of insect-infested Bengal gram under vacuum and modified atmosphere storage in laminated LDPE bags. International Journal of Current Microbiology and Applied Science. 2017; 6(12):4303-4308.
21. Meena MK, Chetti MB, Nawalagatti CM. Seed physiological and biochemical parameters of soybean (*Glycine max*) as influenced by different packaging materials and storage conditions. International Journal of Pure and Applied Biosciences. 2017;5(1):864-875.
22. Deepa GT, Chetti MB, Khetagoudar MC, Adavirao GM. Influence of vacuum packaging on seed quality and mineral contents in chilli (*Capsicum annuum* L.). Journal of Food Science and Technology. 2013;50:153-158.
23. Malimath DS, Merwade MN. Effect of storage containers on seed storability of garden pea (*Pisum sativum* L.). Karnataka Journal of Agricultural Sciences. 2007;20 (2):384-385.
24. Narayanaswamy S. Effect of packaging and location of storage on groundnut seed. In: Proceedings of National Workshop on Groundnut Seed Technology. 2003;6-7.
25. Halim MA, Hossain MM, Haque MM, Solaiman ARM. Seed quality of onion as influenced by maturity stage. Seed Techno. J. 2012;3:9-12.

26. Goel A, Goel AK, Sheoran IS. Changes in oxidative stress enzymes during artificial aging in cotton (*Gossypium hirsutum* L.) seeds. Journal of Plant Physiology. 2002;160:1093-100.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/119310