The Pharma Innovation Journal 2021; 10(7): 1750-1752

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(7): 1750-1752

www.thepharmajournal.com
Received: 13-05-2021
Accepted: 16-06-2021

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Effect of accelerated ageing on quality, growth and yield in seeds (Artificial ageing techniques): Review

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Abstract
Seed ageing is most challenging factor during storage. The biggest issue with seed storage is seed ageing. Seed degradation causes changes in enzyme activity as well as a decline in seedling growth. The seed must be kept until the following sowing or sold in the market after harvesting. If sufficient care is not taken during this time, the seed's germination and vigour may quickly degrade. Seed ageing is linked to a number of changes, including loss of membrane integrity, solute leakage, decreased energy metabolism, RNA (protein synthesis) impairment, and DNA degradation. Accelerated ageing, which is known to diminish seed viability and vigour in different seed crops, has been used to predict seed storability. The goal of this study was to see how accelerated ageing affected quality characters in different seeds and predict storage potential.

Keywords: Seed ageing, accelerated ageing test, degradation, enzymatic activities

Introduction
Delouche (1965) [5], referenced in AOSA (1983) [5], established accelerated ageing as a seed quality test at Mississippi State University's seed technology laboratory. It was created as a test to determine how long seeds would last in warehouse storage. Following investigations have confirmed the test's accuracy in estimating the life duration of a variety of seed species under a variety of storage circumstances (Delouche and Baskin, 1973) [6]. The technique involved the exposure of seeds to adverse levels of temperature (40-45 ºC) and 100% R.H. for varying length of time followed by regular germination test. The seeds absorbed moisture from the humid atmosphere and aged rapidly due to high temperature. The basis for this test is that higher vigor seeds tolerate the high temperature-high humidity treatment and thus retain their capability to produce normal seedlings in the germination test. Accelerated aging test has been suggested and recommended in many crops such as wheat, sorghum, corn, beans, soybean, onion, radish and lettuce (AOSA, 1983; ISTA, 1995) [5].

Accelerated aging test principle
In accelerated aging process, the seeds are subjected to high temperatures and relative humidity in a laboratory prior to regular germination. Seed batches that performed well in the accelerated ageing test are expected to maintain viability in ambient storage. As a result, the ageing test can be used to predict how well a seed lot will function in ambient storage. The vitality of Bragg soybean seeds after 6 months of ambient storage and three days accelerated ageing test (42-45 °C temperature, 95 to 100 percent RH) was found to be favourable (Gupta, 1980) [11]. However, accelerated ageing test results that were not substantially related to maize and soybean field emergence were inconsistent, according to Perry (1984) [22]. The test is also influenced by fungus growth on the seeds under high temperatures and humidity (Agrawal. 1987) [1]. This test is recommended for soybean seeds.

Apparatus and equipment required
Accelerated ageing chamber, germination test equipment, seed samples, tight jar, muslin cloth, wire mesh, and other items.

Procedure
A delicate muslin cloth is knotted around 100 seeds in four replications. On a wire mesh, the tied seeds are placed in a jar. The jar's lower half is filled with water. Water should not come into direct contact with the seed. To make it airtight, the jar is covered with the lid and sealed with Parafin wax.

After that, the jar is placed in an accelerated ageing chamber that is kept at 45 °C for 3-5 days. After this time, the container is removed and the seeds are chilled in a dessicator. The seeds are subsequently put through a standard germination test for various crops. The level of seed vigour is determined by the percent germination. The higher the germination percentage, the more vigorous the plant.

To normalize the accelerated ageing test, many researchers have attempted. Here are a few other studies that are discussed: Accelerated ageing is a fast-acting technique for determining seed quality and vitality (Khan *et al*., 2007; Kibinza *et al*., 2006) [16, 18]. Increased ageing period of maize (*Zea maize* L.) seeds resulted in a larger decline in germination properties, according to Siadat *et al*., 2012 [24]. Seed priming with KNO_3 improved seed germination in old seeds. Siri *et al*., 2013 found that osmopriming (PEG_{6000} with -1.5MPa for 6 days) artificially aged sweet pepper seedlings (42 ºC and 100% RH) resulted in enhanced germination and lower levels of malondialdehyde (MDA) and total peroxide. They went on to say that increasing total antioxidant activity (TAA), total ascorbate, dehydroascobate, and catalase (CAT) activity in primed seeds improved the defence mechanism against reactive oxygen species damage to cell membranes. After maturing cabbage seeds for six days at 40 °C, Smolikova and Medvedev (2015) [26] found a 2.5-fold rise in carotenoid levels. Carotene concentration in seeds aged in 100% relative humidity at 40 °C rapidly declined, ROS levels increased 2.5 times, and wheat seeds completely lost their germination capacity. Seed breakdown after AA is a sign of decreased enzymatic activity and total soluble protein concentration in wheat, according to Moori and Eisvand (2017) [19]. In Jatropha curcas seeds, the total soluble protein content decreases with storage time. (Silva *et al*., 2018) [25]. Oil content decreased during storage and AA in the seeds of Jatropha curcas (Lozano-Isla *et al*., 2018), Arabidopsis thaliana (Oenel *et al*., 2017) [20], and sunflower (Baleevi-Tubi *et al*., 2005) [3]. Onder *et al*., 2020 suggested that The AA at 43 °C was suitable for assessing the effects of ageing in safflower genotype. During the AA, carotene, xanthophyll, soluble phenolics, flavonoid, soluble protein, soluble sugars, oil content, and MDA levels declined, while reducing sugars and total free fatty acids increased in varied degrees among genotypes. In age resistant genotypes, total tocopherol content increased, but in ageing sensitive genotypes, it dropped.

The predominant cause of seed destruction during the A.A. was not lipid peroxidation, as revealed by MDA levels in safflower seeds. According to (Kibinza *et al*. 2006) [18] rapid ageing impaired seed germination, and priming therapy partially restored the ageing effect. Catalase inhibition by aminotriazol during priming treatment inhibited seed healing, showing that catalase plays a vital role in age-related protection and repair mechanisms. These findings show that priming causes the production of catalase, which is crucial in seed recovery during priming. Slow hydration of germinating seeds prevented seed electrolyte leakage, according to Tilden and West, indicating that cell membrane permeability or rupture was a major factor contributing to the loss of germinability after ageing. Gonzalez-Zertuche *et al*., 2011 found that priming Wigandia Urens aged seeds enhanced protein concentration and caused the synthesis of heat stable proteins of 14 and 23 kDa in aged seeds, as well as proteins of high molecular weight of 43 kDa in primed seeds, which were not found in control seeds. Hydro-priming of aged chickpea seeds corrected seed degradation and improved field performance, according to Ghassemi-Golezani *et al*., 2012 [8]. By using the AA test, Fabrizius *et al*., 1999 [7] were able to estimate the actual germination rate of soybean seed during natural ageing, with the key determinants being the length of natural ageing and the degree of seed deterioration. Soybean seedlings lost vigour, viability, and the time it took to reach 50% seed germination (T50) after 30 days of AA treatment at 99.5 percent relative humidity and 32 ºC. Govindraj *et al*., 2017 found that accelerated ageing on germination, seedling vigor and biochemical constituents of manually and mechanically harvested and threshed rice varieties revealed that their ability to germinate and produce vigor's seedlings which are mainly due to varied resistance to deteriorative changes. Iqbal *et al*., 2002 [12] revealed that the extended period of accelerated ageing up to 20 days resulted in complete of loss of germinability. The main cause of seed deterioration by accelerated ageing might be membrane disintegration and inactivation of enzymatic systems mainly due to lipid peroxidation and increase in free fat acidity. Kapoor *et al*., 2010 [14] found that the main cause of lower vigour index owing to faster seed ageing is a reduced capacity to germinate and produce vigorous seedlings and growth efficiency and seedling vigor as a result of ageing effects with regard to varietal responses. Somasundaram and Bhaskaran (2017) [27], suggested that 20 days of accelerated ageing is considered as optimum duration of ageing for screening the genotypes for seed longevity in rice. According to Kavitha *et al*. (2017) [15], embryonic axis cells were clearly visible and intact in new seeds, but collapsed in both accelerated and normally aged black gram seeds. When the ageing time was extended, the harm was significant.

The sunflower hybrid (RSFH-130) seeds were subjected to accelerated ageing to determine their relative storability and that, due to unfavorable environmental circumstances, germination of the seeds was reduced as the number of hours for the treatments was increased. The minimal seed certification standards were maintained after 4 months of storage (A.A. at 90 to 95 percent RH and 41 °C for 48 hours). The accelerated aged seeds are reduced in the minimum seed certification standards as storage grows, and the treatments discovered statistically superior, and we can store the seeds for roughly 4 months if the same environmental element exists according to Kumar *et al*. (2015). Incomplete or incorrect vital enzyme production, essential enzyme inactivation, and decreased biochemical activity were all induced by accelerated ageing in seeds (Kapoor *et al*., 2010) [14]. (Chan and Lassim, 2019) [4] demonstrated that accelerated aging was found to have significantly deleterious effects on mungbean seed quality. The laboratory experiments demonstrated that high vigour seeds outperform low vigour seeds in almost all traits evaluated. The extent of deterioration corresponded linearly with temperature and duration of aging. The higher the temperature and the longer the aging duration, the more severe was the damage. Khan *et al*., (2016) [17] suggested that seed deterioration due to age is a natural and inexorable phenomenon governed by a variety of metabolic activities, particularly those related to protein and lipid metabolism, as well as the production of free radicals and the antioxidant system present in the seed.

Conclusion

The seed quality is affected by humidity, temperature, and the length of time seeds are exposed to ageing conditions,

according to the studies above. The accelerated ageing test is well-known for estimating seed storability. It is used in seed warehouses to determine which lots have a high possibility for carryover (maintain germination level over prolonged storage). As a result, many crops' seed vigour is determined using this technique.

Acknowledgement
The author is grateful to the Hon'ble Vice Chancellor, HOD and Advisor, at Sam Higginbottom University of Agriculture, Technology, and Science Prayagraj, Uttar Pradesh, for providing all required facilities and support.

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