Scholars Academic Journal of Biosciences (SAJB) **ISSN 2321-6883 (Online)**
Sch. Acad. J. Biosci., 2015; 3(8):708-711 **ISSN 2347-9515 (Print)**
©Scholars Academic and Scientific Publisher
(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com **DOI :** 10.36347/sajb.2015.v03i08.013

Research Article

Accelerated aging declines the germination characteristics of the maize seeds

Ranganathan Kapilan
Department of Botany, University of Jaffna, Jaffna, Sri Lanka

***Corresponding author**
Ranganathan Kapilan
Email: ranganat@ualberta.ca

Abstract: The objective of the study was to determine the role of aging on maize seed germination characteristics and enzyme activity. Maize seeds were incubated in completely covered plastic boxes for the aging experiment. Accelerated aging regimes were performed by maintaining the maize seeds at 40°C and 90 % relative humidity for 0, 2, 4, 6 and 8 days in triplicates. When aging period increased, the germination characteristics and production of enzymes showed a reducing trend. The effect of the treatments on the germination characteristic parameters such as percentage of germination, general normal seedling percentage, germination index, enzyme producing capacity and mean time to germination, under conditions provided for aging were significant ($P < 0.05$) with accelerated aging of maize seeds. Biochemical and enzymatic changes that occur inside the seed and reduction of seedling growth are consequences of deterioration of maize seed. Germination characteristics and enzyme activity of the maize seeds were higher at the initial stages of aging while the same were lower towards the final stages of the aging.
Keywords: Aging, Germination characteristics, enzyme activity, maize seed

INTRODUCTION

Generally seeds are very susceptible and sensitive to the adverse environmental conditions. The natural oil inside the seeds will undergo diverse biochemical changes and this will lead to the deterioration and damage of the seed, during the period of storage [14]. Seed aging is one of the major issues in the storage of seeds and the storage condition of seeds influences the germination characteristics and vigor potential of the seeds [20]. Temperature during seed producing stage, pests and diseases, seed oil and moisture content, mechanical damages, storage time and relative humidity of store are some of the important environmental conditions that may affect the vigor of seeds [17]. Seed aging is one of the important unavoidable process in seed's life time and influenced mainly by temperature and moisture content [7].

The storage environment where the seeds are stored greatly influences the time period of the survival of the seeds [6, 7]. Seed deterioration leads to the reduction in the germination capacity and quality, viability and vigor either due to aging or role of adverse environmental conditions [13, 19, 25]. Decrease in seed vigor may be due to decrease in the germination characteristics or indices, and also it can increase the susceptibility of seeds to environmental stress [27]. The oxidative damages cause the major deterioration changes observed in aged seeds [9]. Free radical oxidations, enzymic dehydrogenation and oxidation of aldehydes of protein molecules might influence the progress of seed quality. Acceleration of aging of seeds of diverse crops is a treatment that is widely used to determine the seed storage quality, germination characteristics induced by natural aging conditions [8, 23].

Maize is one of the nature's treasures that gathered a diverse reputation. Maize is a staple food that provides almost everything to people in many countries of this planet[25,26]. Corn intake is often associated with good overall fiber intake [18]. Plentiful seeds of corn are very popular for the health benefits from head to toe. Corn is highly preferred for its richness in antioxidant phytonutrients such as anthocyanins, beta-carotene, caffeic acid, coumaric acid, ferulic acid, lutein, syringic acid, vanillic acid, protocatechuic acid and zeaxanthin [25, 27]. The percentage of amylose starch found in corn may be related to its antioxidant capacity. Higher amylose corn varieties have shown higher antioxidant capacity [19, 20]. The ability to provide many B-complex vitamins including vitamins B1, B5 and folic acid, and its notable protein content, corn is a food that provides blood sugar benefits. Consumption of corn in ordinary amounts has been shown to be associated with better blood sugar control in both type 1 and type 2 diabetes. Amylase enzyme in maize improves the efficiency and environmental footprint of biofuels [4]. There are numerous studies going on in examining the ability of corn to improve overall nourishment, especially when combined with legumes. Corn is also highly preferred for its potential role in anti-HIV activity. Corn oil (maize oil) is extracted from the germ of corn. The main use of corn oil is usage in cooking, where its high smoke point makes refined corn oil a valuable frying oil. Corn oil is a key ingredient in some margarine types. Corn oil is generally less expensive than most other types of vegetable oils. High-oil varieties have been developed from corn. Corn oil is also a feedstock used for biodiesel [29]. Other industrial usage of corn oil includes production of soap, salve and paint, rust proofing for metal surfaces and production of inks, textiles, nitroglycerin and insecticides. Corn oil can also be used as a carrier for drug molecules in pharmaceutical preparations.

Accelerated aging of maize seeds is done by placing the seeds at high temperature and relative humidity. This is associated with a progressive decrease in the germination capacity of the maize seed. How aging influences the germination properties, production and activity of the seed enzymes and the rate of germination of the corn seeds have not been completely determined yet. What happens to the enzymes and antioxidants and the oil store in the seeds can be determined for improved vigor and germination potential of the corn seeds. Therefore, this study was aimed to determine the effect of aging on germination characteristics and enzyme production of maize seeds.

MATERIALS AND METHODS

Sampling method

Corn seeds were treated with different accelerated aging periods of 0, 2, 4, 6 and 8 days at 40°C in sealed plastic boxes with 100% relative humidity. Standard germination tests were done after that at 25°C for 8 days [3] in triplicates of 50 seeds in a completely randomized design plan.

Analytical approach

The germinated corn seeds (based on the emergence of germ tube) were counted everyday to calculate the germination rate. At the end of the germination period, germination percentage, normal seedling percentage, germination index and mean time to germination were calculated. All extraction procedures were carried out at 4 °C. The seed samples were homogenized with 3 ml of Tris buffer (PH 7.8), followed by centrifugation of 20000 g for 20 min using Beckman J2-21M/E refrigerated centrifuge equipped with a JA-20 rotor (Beckman Coulter, Brea, CA, USA) [4, 5]. The supernatants were used to determine the enzyme activities of Catalase and Ascorbate peroxidise. Catalase (CAT) activity was determined spectrophotometrically following H_2O_2 consumption at 240 nm. Ascorbate peroxidase (APX) activity was determined by the method explained by Johnson and Cunningham [12]. The activities of APX and CAT were expressed per mg protein, and one unit represented 1 µmol of substrate undergoing reaction per mg protein per min.

Statistical analysis

Statistical analyses were performed using R 2.15.3 statistical software at $\alpha = 0.05$ confidence level. The data sets were checked for the parametric assumptions of normality (Shapiro-Wilk and Kolmogorov-Smirnov tests) and homogeneity of variances (Bartlett's test). Box plots were used for identifying outliers from the data set that were removed before the statistical analysis. When necessary to meet the assumptions of normality and homogeneity of variance, the data were transformed, either by log transformation or square root transformation. The data were analyzed using ANOVA. Tukey's multiple comparison test was used to determine significant differences at $p \leq 0.05$ [30].

RESULTS AND DISCUSSION

The effect of priming treatments on the parameters such as percentage of germination, germination index, general normal seedling percentage and mean time to germination, under conditions provided for aging were significant ($P < 0.05$). This finding supports the previous studies done in different oil seeds [4, 10, 19, 25]. This confirms the seed treatment results in negative affect on the characteristic features of germination. The highest percentage of germination (Figure 1), germination index (Fig- 2), normal seedling percentage (Figure 4) were obtained under 0 and 2 day of aging of the seed, and the minimum, mean germination time (Fig-3) was achieved under 3 days of aging of the seed.

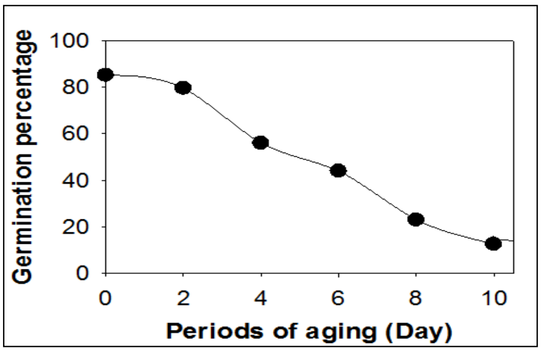

Fig-1: Effect of aging on the percentage of germination in the maize seeds

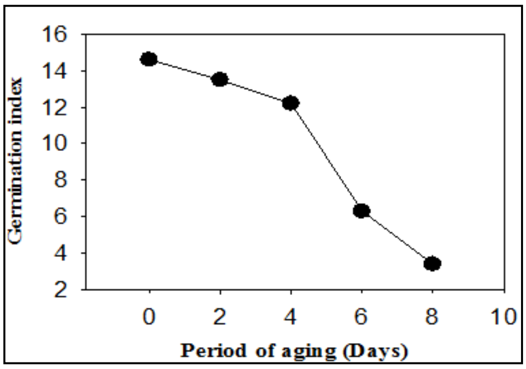

Fig-2: Effect of aging on the germination index of maize seeds

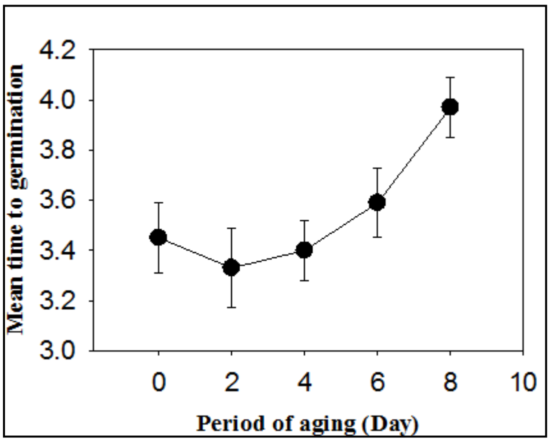

Fig-3: Effect of aging on the mean time of germination of the maize seeds

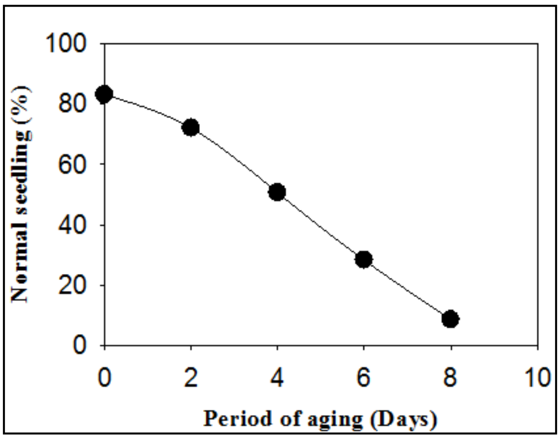

Fig-4: Effect of aging on the percentage of normal seeding of the maize seeds

When the duration of aging period was increased, these traits reduced. Therefore 8 days of aging period was chosen and minimum traits were attained. Number of seeds germinated was reduced with increasing seed age and similar trend was obtained by JanMohammadi et al. [11] and [9] in rape seed, by Bhattacharjee et al. [5] in common bean and by Saha and Sultana, [24] in soybean. Negative effect of aging was observed in parameters such as seed performance, germination percentage and seedling indices showed negative effect of aging [4, 10, 19, 21, 25]. Decreasing in the percentage of germination might be due to the chromosomal aberrations that take place under long term storage conditions of seeds [2, 26]. Aged seeds show a decreasing trend in germination percentage and this may be due to the reduction of enzyme (α-amylase and other hydrolytic enzymes) activity and the amount of carbohydrate storage [4, 28] or the tendency of proteins undergoing denature during long term storage [22]. When barley and pea seeds were treated with different combinations of accelerated aging treatments, it was able to find out that the amount of genetic damage was mainly due to a function of loss of viability [1]. After 8 days of deterioration, germination percentage of seeds was very low. Increase in aging time significantly decreases percentage of germination.

The enzyme activity started to decrease in the corn seeds after aging (Fig-5). Lost or decrease in the enzyme activity in the aged seeds of similar seeds were reported [4, 10, 16]. During the priming process, catalase is the enzyme that plays major role in the recovery of seeds from aging [15].

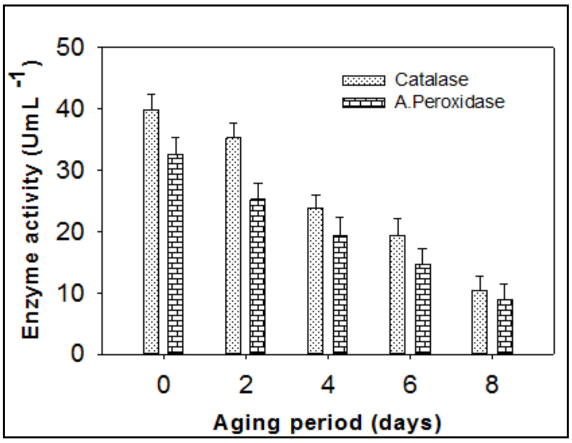

Fig-5: Effect of aging period on the catalase and ascorbate peroxidise enzyme activities that are accumulated in the maize seeds

CONCLUSION

The decline in the characteristics of germination in response to aging is a consequence of decline in enzyme activity in maize seeds. The highest germination characteristics and enzyme activity were attained in the initial stages of aging and the lowest at the final stage of the aging experiment.

ACKNOWLEDGEMENT

The author would like to express his deep sense of gratitude and sincere thanks to Dr.Mohan, Thiagarajah, University of Alberta for his kind support and the laboratory facilities.

REFERENCES

1. Abdalla FH, Roberts EH; Effects of temperature, moisture and oxygen on the induction of chromosome damage in seeds of barley, broad beans and peas during storage. *Ann* Bot (N.S.), 1968; 32: 119-136.
2. Akhter FN, Kabir G, Mannan MA, Shaheen NN; Aging effect of wheat and barley seeds upon germination mitotic index and chromosomal damage. J Islam Acad Sci, 1992; 5: 44-48.
3. Anonymous; International rules for seed testing. International seed testing association (ISTA) Switzerland, 2010.
4. Bailly C, Benamar A, Corbineau F, Côme D; Changes in malondialdehyde content and in superoxide dismutase, catalase and glutathione reductase activities in sunflower seeds as related to

deterioration during accelerated aging. Physiol Plantarum, 1996; 97: 104-110.
5. Bhattacharjee A, Kanp UK, Chakrabarti D, Pati CK; Technique for storage longevity of mung bean and sunflower seeds using sodium dikegulac and Eucalyptus oil. Bangla J Bot, 2006; 3: 55-61.
6. Ellis RH, Osei-Bonsu EE, Roberts EH; The influence of genotype, temperature and moisture on seed longevity in chickpea, cowpea and soybean. J Annul Bot, 1982; 50: 69-82.
7. Ellis RA, and EH, Roberts; The quantification of ageing and survival in orthodox seeds. Seed Sci. Technol, 1981; 9: 373-409.
8. Galeshchi L, Capoochi A, Ghiringheli S, Saviozzi F, Caliccu L, Pinzino C, Zandomeneghi M; Antioxidants, free radicals, storage proteins and proteolytic activities in wheat (*Triticum durum*) seeds during accelerate aging. J Agric Food Chem, 2002; 50: 5450-5457.
9. Ghassemi-Golezani K, Khomari S, Dalili B, Hosseinzadeh-Mahootchy B, Chadordooz-Jedi A; Effect of seed aging on field performance of winter oil seed rape. J Food Agric Envir, 2010; 8(1): 175-178.
10. Goel A, Goel AK, Sheoran IS; Changes in oxidative stress enzymes during artificial aging in cotton (*Gossypium hirsutum* L.) seeds. J Plant Physiology, 2002; 160: 1093-1100.
11. Jan-Mohammadi M, Fallahnezhad F, Golsha M, Mohammadi H; Controlled aging for storability assessment and predicting seedling early growth of canola cultivars (*Brassica napus* L.). ARPN J Agric Biol Sci, 2008; 3: 22-26.
12. Johnson LB, Cunningham BA; Peroxidase activity in healthy and leaf-rustinfected wheat leaves. Phytochemistry, 1972; 11: 547– 551.
13. Kapoor N, Arya A, Siddiqui MA, Amir A, Kumar H; Seed deterioration in chickpea (*Cicer arietinum* L.) under accelerated aging. Asian J Plant Sci, 2010; 9(3): 158-162.
14. Kausar M, Mahmood T, Basra S M A, Arshad M; Invigoration of low vigor sunflower hybrids by seed priming. Int J Agric Biol, 2009; 11: 521-528.
15. Kibinza S, Bazina J, Bailly C, Farrant J M, Corbineaua O, Bouteaua H; Catalase is a key enzyme in seed recovery from aging during priming. *Plant* Science, 2011; 181: 309- 315.
16. Krishnan P, Nagarajan S, Dadlani M, Moharir AV; Characterization of wheat (*Triticum aestivum* L.) and soybean (*Glycine max* L.) seed under accelerated aging condition bye proton nuclear magnetic spectroscopy. J Seed Sci Technol, 2003; 31: 541-550.
17. Marshal AH, Levis DN; Influence of seed storage conditions on seedling emergence, seedling growth and dry matter production of temperate forage grasses. J Seed Sci Technol, 2004; 32: 493-501.
18. Mark Clayton; Christian Science Monitor, 2008, the Christian Science Monitor, Retrieved August 29, 2015.
19. McDonald MB; Orthodox seed deterioration and its repair, In: Handbook of Seed Physiology: Applications to Agriculture, Benech-Arnold R L and R.A. Sanchez (Eds.). Food Products Press, New York, 2004; 273-304.
20. McDonald MB; Seed deterioration: Physiology, repair and assessment. J Seed Sci Technol, 1999; 27: 177-273.
21. Moradi A, Younesi O; Effects of Osmo- and Hydro-priming on Seed Parameters of Grain Sorghum (*Sorghum bicolor* L.). Australian Journal of Basic and Applied Science, 2009; 3(3): 1696-1700.
22. Nautiyal AR, Thapliyal AP, Purohit AN; Seed viability IV. Protein changes: Accompanying loss of viability in Shorea robusta. Seed Sci Technol, 1985; 13: 83-86.
23. Nick SMM, Tilebeni HG; Effect of seed aging on heterotropic seedling growth in cotton. American-Eurasian J Agri Environ Sci, 2011; 10: 653-657.
24. Saha RR, Sultana W; Influence of seed aging on growth and yield of soybean. Bangla J Bot, 2008; 37: 21-26.
25. Siadat SA, Moosavi A, Sharafizadeh M; Effect of seed priming on antioxidant activity and germination characteristics of Maize seeds under different aging treatments. Research Journals of Seed Science, 2012; 5(2): 51-62.
26. Subedi KD, Ma BL; Seed priming does not improve corn Yield in a humid temperate environment. Agron. J, 2005; 97: 211-218.
27. TeKrony DM, Egli DB, Wickham DA; Corn seed vigor effect on notillage field performance. J Crop Sci, 1989; 29: 1523-1528
28. The cassava transformation in Africa; The Food and Agriculture Organization of the United Nations (FAO), 2006.
29. Vallabhaneni R, Wurtzel ET; Timing and biosynthetic potential for carotenoid accumulation in genetically diverse germplasm of maize. Plant Physiol, 2009; 150 (2): 562–72.
30. R Development Core Team: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria, 2011.