Effect of different aging treatments on the vigor of high-oleic acid peanut seeds

H Wang¹,², S T Yu¹,³,⁴, C T Wang²,³, G Q Yu¹, X Y Cui¹, S L You¹, Z Y Gao¹, P X Shi¹, H B Yu¹ and L Ren¹

¹Institution of Sandy Land Management and Utilization of Liaoning, Fuxin 123000, China
²Shandong Peanut Research Institute, Qingdao 266100, China
³Shenyang Agriculture University, Shenyang 110866, China

Email: shutaoyu@163.com

Abstract. Accelerated aging is known to reduce seed viability and vigor in many crop species. This study was undertaken to evaluate the effect of accelerated aging on germination potential, germination percentage, electric conductivity, acid value and peroxide value. Compared with common peanut, high oleic acid peanut were more beneficial to health and can significantly improve the storability of seed. Eight high oleic acid (range of oleic acid content: 74.95%-80.6%) and two common varieties were used in this experiment. Six treatments were contained, natural aging of kernels, natural ageing of pods, accelerated aging was achieved by incubating seed at 40°C and 100% relative humidity in a closed chamber for 4, 6, and 8 days. The results showed that: the changes of germination potential and germination percentage of natural aging were not significant for high oleic acid peanuts, smaller than that of the common varieties. No matter artificial aging or natural aging treatment, compared with non-aging treatment, electric conductivity gradually increased, but high oleic acid varieties remained at low levels. The acid value of each variety increased gradually with the aging time, comparison between aging treatments, the difference between high oleic acid varieties was not significant, not the same with the common varieties. The peroxide value of 8 high oleic acid varieties was zero under each aging treatment, but the peroxide value of two common varieties increased with the aging time. The variation rules of all indicators of artificial aging for 4 days and 6 days were the same with
the two natural aging treatments. So artificial aging for 4 days and 6 days can be used for high oleic acid aging test, replace natural aging, which not only shortens the test time but also ensuring the best effect.

1. Introduction

Seed aging relates to the phenomenon that seed vigor naturally declines during storage [1]. Seed vigor reflects the ability of the potential germination, emergence and storage of seeds, it reaches its highest level at physiological maturity, then decline. The seed deteriorating and aging, seed quality will be affected, including seed germination, seedling growth and development, so attention has been put on seed aging research.

The four seasons of Liaoning province in the northeast peanut production area are distinct, peanut cultivation system is one harvest a year, oleic acid content of currently extended peanut varieties is less than 45%, so higher demand for safe storage of peanut seeds is needed by peanut seed producers and operators. Previous studies on the aging of common peanuts were more frequent, while there were fewer studies on high oleic acid peanuts. Screening peanut germplasm which is resistant to accelerated aging with relative germination percentage [2], it was found that the aging resistance of peanut was positively correlated with oleic acid content in some treatments, but negatively correlated with linoleic acid content, but no study on high oleic acid peanut.

High temperature and high humidity aging are the most commonly used artificial accelerated aging method, which is widely used in research on storability of various seeds [3-4]. In this study, 8 high oleic acid peanut varieties with different oleic acid content and 2 common varieties were used. By measuring the vigor and quality of the seeds, inquiring the influence of artificial aging and natural aging on the vigor and quality of seeds. So, providing a basis for the safe storage of high oleic acid peanuts and technical support for the promotion of high oleic acid peanuts.

2. Materials and methods

2.1. Materials

Seeds of peanut were obtained from Institution of Sandy Land Management and Utilization of Liaoning. Ten varieties including 8 high oleic acid peanuts with different oleic acid content and a certain gradient and two common varieties Fuhua20 and Fuhua24. The content of oleic acid and linoleic acid were detected by gas chromatography (Agilent 7820), O/L is the content of oleic acid divide the content of linoleic acid. 100-seed mass was weight of 100 randomly selected seeds. The quality data were shown in table 1:
Table 1. Quality characteristics.

|          | L95  | L88  | L92  | S52  | L107 | L14  | L34  | L30  | Fuhua24 | Fuhua20 |
|----------|------|------|------|------|------|------|------|------|---------|---------|
| Oleic acid (%) | 80.6 | 78.94| 78.96| 78.24| 76.2 | 76.5 | 74.73| 74.95| 42.9    | 38.2    |
| O/L        | 20.30| 20.29| 20.19| 17.01| 15.74| 14.83| 11.92| 10.89| 1.30    | 0.91    |
| 100-seed mass (g) | 71.19| 70.26| 69.94| 63.18| 69.01| 82.73| 72.86| 73.41| 85.49   | 98.70   |

2.2. Treatments

Five treatments were contained, natural aging of kernels, natural ageing of pods, artificial aging of kernels for 4 days, artificial aging of kernels for 6 days, artificial aging of kernels for 8 days, and no aging for kernels as a control.

The method of natural aging: after harvested, the pods were dried naturally until the water content was lower than 10%, then were preserved including kernels and pods, the total storage time was 20 months (October 2015 to June 2017).

The method of artificial aging and the control: the kernels used for artificial aging was the same with the control. According to local production habits, after drying naturally (the water content was lower than 10%) the pods were sent to storage for 8 months (October 2016 to June 2017), it was the control. Then the kernels were put under high temperature and high humidity conditions (T(temperature) = 40℃, RH (relative humidity) = 100%) for four, six and eight days separately and then dried for 3-4 days naturally.

2.3. Measuring methods

Germination percentage and germination potential: germination percentage (%) = Germination number on the 7th day/ total number of experimental seeds × 100%; germination potential (%) = number of seed germination on 4th day / total number of experimental seeds × 100% [5].

Electric conductivity (EC) and relative conductivity (RC): three replicates per variety, 20 seeds per variety, after weighed (W), washed with deionized water, soaked in 30ml distilled water for 24h, then electric conductivity been measured (d1). Then boiled for ten minutes and measured conductivity again (d2), use the same amount of distilled water as a control (CK). They were calculated using the following formulas:

\[ EC = \frac{(d1-d2)}{W} \]
\[ RC = \frac{(d1-CK)}{(d2-CK)} \times 100\% \]

Acid value and peroxide value were measured based on the analytical method of GBT5009.37-2003 edible vegetable oil hygiene standard.

2.4. Data analysis
Statistics and correlation analysis were performed using Excel software and DPS software.

3. Results

3.1. Analysis of variance

It can be seen from Table 2 that the effects of different aging treatments, different varieties and their interactions on peanut germination potential, germination percentage, electrical conductivity, relative conductivity and acid value were significant.

| Variation source      | df | Germination potential | Germination percentage | Electric conductivity | Relative conductivity | Acid value |
|-----------------------|----|-----------------------|------------------------|-----------------------|-----------------------|------------|
|                       |    | MS                    | MS                     | MS                    | MS                    | MS         |
| Treatments            | 5  | 1.03**                | 0.76**                 | 121393.64**           | 1.74**                | 0.06**     |
| Varieties             | 9  | 0.13**                | 0.08**                 | 10557.07**            | 0.09**                | 0.06**     |
| Treatments x Varieties| 45 | 0.002**               | 0.01**                 | 2282.39**             | 0.02**                | 0.02**     |

Notes:**significance level at 0.01

3.2. Changes of germination potential and germination percentage

As shown in Figure 1, under different aging treatments, germination potential and germination percentage of high oleic peanut varieties was higher than that of the common varieties, and the variation trend of each variety were consistent. The control > natural aging of pods > natural aging of kernels > artificial aging of kernels for 4 days > artificial aging of kernels for 6 days > artificial aging of kernels for 8 days.

Compared in varieties, germination potential of S52 and L107 was the highest in all aging treatments except for L30 whose was the highest in artificial aging for 8 days. The lowest germination potential under each treatment was common varieties Fuhua20 and Fuhua24, which were significantly lower than high oleic acid variety.

The results of natural aging of pods were similar with the natural aging of kernels. The germination percentage gradually decreased with the aging time increased. Except for L14, trend of artificial aging was similar with natural aging. Germination percentage decreased with the decrease of oleic acid content.

Compared with the control, germination percentage of varieties with an O/L higher than 10 under all aging treatments were all above 50%, and the smallest was 51%. While the germination percentage of two common varieties Fuhua20 and Fuhua24 significantly reduced, after artificial aging for 6 days and 8 days. And the germination percentage decreased to 35.2% and 41.6% respectively of artificial aging for 8 days.
5th International Conference on Agricultural and Biological Sciences (ABS)  
IOP Conf. Series: Earth and Environmental Science 346 (2019) 012061  
doi:10.1088/1755-1315/346/1/012061

Figure 1. Changes of germination potential and germination percentage of various varieties under different aging treatments.

3.3. Comparison of electric conductivity under different aging treatments

As shown in Figure 2, under different aging treatments, electric conductivity of high oleic acid peanut varieties was generally lower than that of the common varieties under the influence of saturated fatty acids, and it was lower than that of artificial aging, and the trend was the same: The control < natural aging of pods < natural aging of kernels < artificial aging of kernels for 4 days < artificial aging of kernels for 6 days < artificial aging of kernels for 8 days.

Figure 2. Comparison of electric conductivity under different aging treatments.
It is worth noting that under all aging treatments, electric conductivity of Fuhua24 was always kept at the minimum, probably due to the high crude fat content of it (detected by the Ministry of Agriculture Oil and Products Quality Supervision, Inspection and Testing Center (Wuhan, China) up to 56.08%).

3.4. Comparison of acid value and peroxide value of different varieties

As shown in Figure 3, under all aging treatments, peroxide value of common varieties was higher than high oleic acid varieties. Compared between the treatments, The control < natural aging of pods < natural aging of kernels < artificial aging of kernels for 4 days < artificial aging of kernels for 6 days < artificial aging of kernels for 8 days. With the aging time prolonged, the acid value became higher.

Compared between varieties, common varieties Fuhua20 and Fuhua24 was the highest in all treatments. The acid value of L92 and L95 whose O/L was more than 20 was the lowest in each aging treatments.

![Figure 3](image_url)

**Figure 3.** Comparison of acid value under different aging treatments.

In this study, the peroxide value had been tested through the redox titration method. The result showed that peroxide value of all high oleic acid varieties was zero under all aging treatments, whereas the common varieties Fuhua20 and Fuhua24 were all oxidized.

4. Discussion

There are few studies on the research of artificial aging and natural aging of high oleic acid home and abroad. [6] conducted a natural aging study on high oleic acid peanut, and studied on germination percentage, electric conductivity, field emergence and yield, which confirmed that high oleic acid peanut has good storability. This study combined natural aging and artificial aging of different days, the same results with Wang. Shen Yi found that, germination percentage of the common peanut was less
than 50% after artificial aging for 2 days [2]. This study found the germination percentage of high oleic acid peanut would be reduced to 60% after 8 days of artificial aging. It can be seen that high oleic acid peanut has less damage to the cell membrane after aging, which better maintains the integrity of the seeds and make the seed vigor still at a high level. Significantly higher than the common peanut. This phenomenon is due in part to aging-induced lipid peroxidation, which has the potential to damage membranes of the seed tissues [1].

The germination potential, germination rate, vigor index and germination index of seeds are reliable indicators reflecting seed vigor [7]. By comparing natural aging with artificial aging, two treatment methods could reflect the vigor of the seed, and with the prolongation of artificial aging time, the storability of the seed is significantly different. Therefore, compared with the long-term natural aging method, artificial aging method can make up for the shortcomings, which can reflect the seed vigor characteristics well, also the same with other research results [8]. The variation rules of various indicators of artificial aging for 4 days and 6 days and the two natural aging treatments were consistent. So artificial aging for 4 days and 6 days can be used for high oleic acid aging test, replace natural aging, which not only shortens the test time also ensuring the best effect.

Eight high oleic acid lines selected have a gradient in oleic acid content. From the result, germination percentage, germination potential, electric conductivity and relative conductivity under different aging treatments were positively correlated with oleic acid content, and negatively correlated with acid value. However, there was also one strain with different changes-S52, whose weight was just 63.18g, and also was resistant to cold tolerance.

In addition, comparing between natural aging of the pods and natural aging of the kernels, the pods have better storability than kernels, because of the pods provide a relative safe space for the kernels. So, keeping shells when storing.

**Acknowledgments**

Authors wishing to acknowledge assistance or encouragement from Shandong Peanut Research Institute and financial support from Foundation items: China Agricultural Research System (CARS-13); The Central Government Guiding Local Financial Special Project (2017108006).

**References**

[1] Sung J M and Jeng T L 1994. Lipid peroxidation and peroxide-scavenging enzymes associated with accelerated aging of peanut seed. *Physiol. Plantarum*. 91: 51-5.

[2] Shen Y, Liu Y H and Chen Z D 2013. Identification and estimation of aging resistant varieties in peanut (Arachis hypogaea L.). *Chin. Agricul. Sci. Bull*. 29(18):67-71.

[3] Xie H, Chen X Z, Qi J, Liu K, Yang L, Wang J L and Nan Z J 2006. Study on seed vigor of the artificial aged seeds in soybean. *J. Beijing Agricul. College*. 21(3):15-7.

[4] Liu M J, Wang T G, Chen S L, Wang C H and Zhao X L 2008. Physiolooycial and seed vigour
changes of maize seeds during artificial aging course. *J. Nuclear Agricul. Sci.* **22**(4):510-3.

[5] Gao H W, Man Q, Pan J, Lei Y Q, Yu H B, Wu M, Zhang W H and Liu L K 2015. Differences in properties of seed vigor between artificially and naturally aged soybean seeds. *Seed*, **34**(1):14-9.

[6] Wang C T, Zhang Q Y, Tang Y Y, Wang X Z, Wu Q, Sun Q X, Li J, Liu F and Wang H 2016. Effects of natural ageing on yield-related traits of high-oleic peanut. *Shandong Agricul. Sci.* **48**(1):44–6.

[7] Yan Q H 2001. *Seed Sci*. Beijing: China Agriculture Press.110- 6; 425-31.

[8] Gao H W, Man Q, Wu M and Lei Y Q 2014. Screening of soybean germplasm with good seed longevity. *Soybean Sci.* **33**(1):6-12.