

STORAGE POTENTIAL OF FLAX (*Linum usitatissimum* L.) SAMPLES - AN INDICATOR OF SEED LONGEVITY DURING *EX SITU* CONSERVATION

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Summary. The article examines the effectiveness of the accelerated seed aging method for assessing the storage potential of flax samples for *ex situ* conservation in active genetic bank collections. The use of this method, which involves incubation of seeds at high temperature and humidity, allows the effects of unfavourable environmental factors to be adequately modelled and their influence on seed stability to be predicted. Various morphophysiological and biochemical parameters were used to determine the storage potential of seeds in order to predict their successful storage in the plant genome bank. Flax samples with high storage potential were identified. The data obtained indicate that the accelerated seed aging test allows the evaluation of differences in resistance between different varieties of important crop species.

Keywords: flax, storage potential, accelerated aging, germination, electrolyte leakage

Introduction

In the *ex situ* conservation of plant germplasm in plant genetic banks, one of the main challenges is to maintain the viability of seeds, as seeds gradually lose their germination and genetic homogeneity as a result of aging [9]. Therefore, studying the storage potential (SP) of seeds is a very important step in the *ex situ* conservation of plant genetic resources, especially for the long-term storage of collection samples in a plant genetic bank. Many plant genetic banks of different countries have widely used and defined this term in the last decades [4, 6]. To study the storage potential, which indicates the longevity of collection samples during storage, the method of accelerated aging (AA) of seeds is of great interest. The essence of the method is to artificially accelerate the aging process by exposing seeds to elevated temperature and high relative humidity for a relatively short period of time [3]. There are a number of papers comparing physiological and biochemical changes in seeds under accelerated aging and long-term storage. After the accelerated seed aging test, various morphological, physiological and biochemical parameters can be used to assess the seed storage potential, which is a complex indicator and allows the evaluation of differences between varieties of different crop species [2, 4, 6]. This test can be used to monitor plant gene pool samples, i.e. to keep a permanent record of seed viability, and to classify genotypes from working and active collections according to different seed aging parameters. The seed AA test allows:

- Identify collection samples that are not suitable for long-term storage in the genebank.
- Make recommendations on the timing of seed propagation.
- Indicate the need to restore the viability of valuable collection samples.

The aim of this research was to determine the storage potential of flax seeds prior to *ex situ* conservation in the plant genetic bank according to various morphological, physiological and biochemical parameters using an accelerated seed aging test.

Material and methods

To determine the storage potential of flax seeds, we used the AA test according to the method described in the *Handbook of vigor test methods* [3]. For flax seeds, it is recommended to conduct AA of seeds at air temperature of 42°C, relative humidity of 80.0 - 90.0%, and aging time of 72 hours. Often it is necessary to adjust these conditions when aging seeds of each specific crop and even of a specific genotype. A different aging temperature was suggested for some flax genotypes we studied: 43°C. Six flax genotypes were tested: *Vizit*, *Batist*, *Belinca*, *Polesskiy-6*, *K-7907* and *Kaufmann*. There were 300 seeds in each variant (in the experiment and in the control). The experiments were conducted in 3-fold repetition. The control was flax seeds of the last reproduction. Experimental data were processed using *Statistica 7* program package.

After accelerated aging of seeds, various morphophysiological parameters of flax seeds and seedlings were determined: germination energy and germination of seeds, root length, raw biomass of spines according to the *International Seed Testing Regulations ISTA* [5]. Electrolyte leakage was also determined by electrical conductivity of solutions with normal and aged seeds [7]. Among biochemical parameters, the activity of peroxidase enzyme was determined in the roots of flax seedlings [8].

Results and discussions

In the experiments with flax genotypes, a slight drop in germination after seed AA was found compared to the control. Different genotypes showed a 9.3 - 18.7% decrease in germination, which may indicate genotypic specificity of the samples (Fig. 1). The seeds of the tested six flax genotypes had a germination rate of 81.3-90.7% after the test, i.e. they showed high

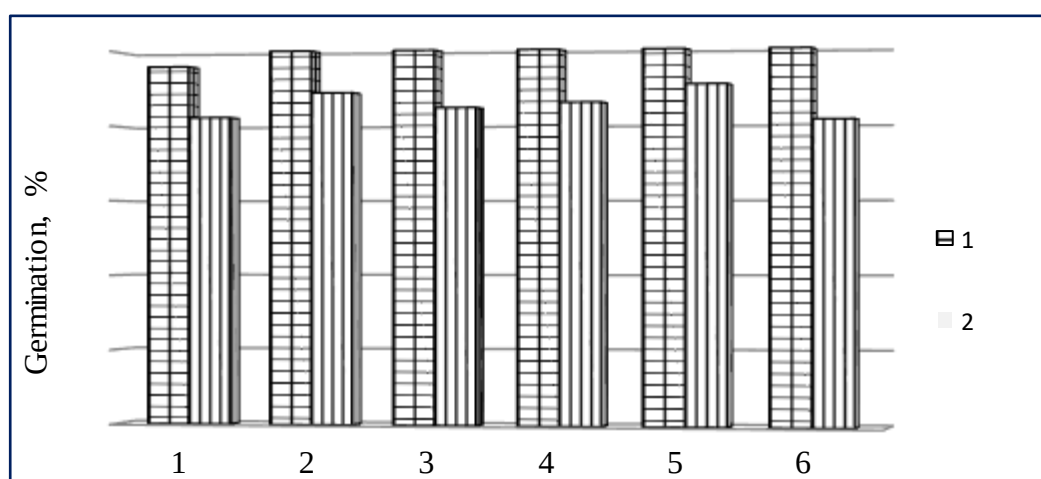


Figure 1. Flax seed germination after AA, %. 1 – Control; 2 – Experiment. Evaluation genotypes: 1- Vizit; 2- Batist; 3- Belinca; 4- Polesskiy-6; 5- K-7907; 6- Kaufmann.

resistance to abiotic stress factors. The harsh conditions of the accelerated aging test (increased air temperature and humidity) did not lead to a significant suppression of seed germination. The minimum decrease in germination of flax seeds after AA was observed in genotypes *K-7907* and *Batist* (by 9.3 and 11.2%, respectively), and the maximum - in genotype *Kaufmann* (by 18.7%).

From the morphophysiological parameters of seedlings, root length, dry and fresh biomass of roots were determined. The maximum decrease in the length of flax seed roots after AA was observed in the genotypes *Belinca* and *Batist* (by 10.7 and 10.4 mm, respectively) (Table). The minimum inhibition of root growth was recorded in genotypes *Vizit* (by 5.8 mm) and *K-7907* (by 4.2 mm).

Genotypes	Variants	Root length, mm	Fresh root biomass, mg
<i>Vizit</i>	C	17.7±1.5	260.0±11.2
	E	11.8±1.8	190.0±10.3*
<i>Batist</i>	C	15.7±1.5	200.0±17.2
	E	5.33±0.7*	160.0±15.4*
<i>Belinca</i>	C	14.6±1.3	170.0±11.0
	E	3.9±0.2*	60.0±9.1*
<i>Polesskiy-6</i>	C	15.7±1.6	170.0±18.9
	E	7.4 ±0.9*	130.0±15.3*
<i>K-7907</i>	C	11.7±0.9	160.0±13.9
	E	7.4±0.5*	110.0±11.6*
<i>Kaufmann</i>	C	15.0±1.1	180.0±21.6
	E	6.8±0.8*	120.0±17.4*

Table. Manifestation of some parameters of flax germs following accelerated seed aging
C- Control; E – Experiment. * - significant differences at $p < 0.05$

The smallest decrease in fresh biomass of roots after seed AA was found in flax genotypes *Batist* and *K-7907* (by 40 and 50 mg, respectively) (Table). It should be noted that flax genotype *K-7907* was the most resistant to abiotic environmental stress factors during accelerated seed aging in a comparative analysis of various morphological parameters.

Almost all flax genotypes showed positive correlation of seed germination with germination energy ($r = +0.63$), root length ($r = +0.65$) and raw biomass of roots ($r = +0.65$).

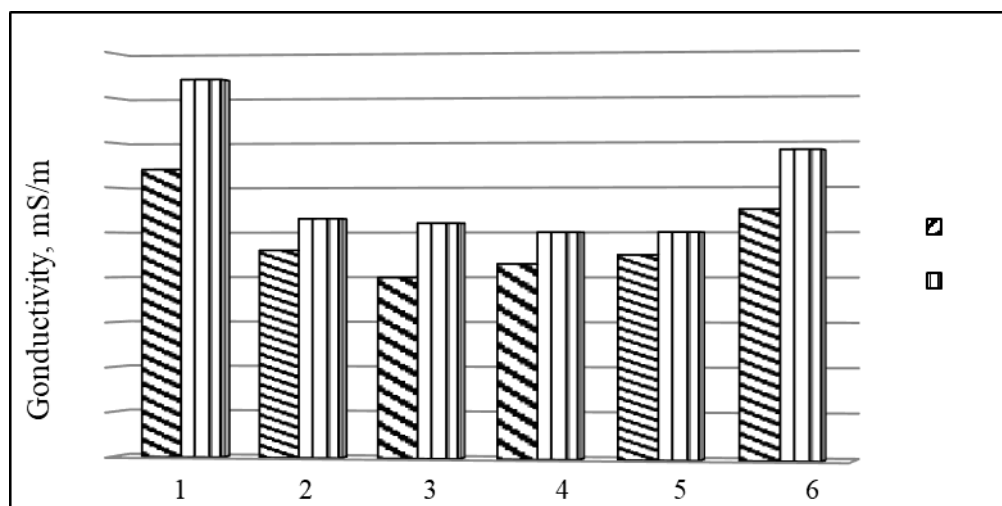


Figure 2. Conductivity of untreated and aged flax seed solutions after the action of the accelerated aging test, mS/m (24 hours). 1 – Control; 2 – Experiment. Evaluation genotypes: 1- *Vizit*; 2- *Batist*; 3- *Belinca*; 4- *Polesskiy- 6*; 5- *K-7907*; 6- *Kaufmann*.

We also determined the electrolyte leakage of seeds after accelerated aging by measuring the conductivity of solutions of normal and aged seeds with the conductometer N5721 at two swelling exposures of 24 and 48 hours. In seeds of aged flax genotypes, no significant differences were obtained between the above exposures. It was found that after AA of flax seeds, the electrical conductivity of solutions increased by 1.1-1.3 times compared to the control depending on the

genotype (Fig. 2). Such a slight increase in electrolyte yield indicates a slight increase in protoplasm permeability after accelerated aging of flax seeds. This fact is favorable for successful *ex situ* conservation of flax collection samples in the plant genetic bank.

Determination of peroxidase enzyme activity after accelerated seed aging in the roots of flax seedlings revealed that the enzyme activity increased depending on the genotype by 1.2 - 1.8 times compared to the control (Fig. 3). This is known to be characteristic of the effect of thermal stress on seeds. The highest increase of peroxidase enzyme content in seedling roots after seed AA compared to control was observed in *Batist* and *Belinca* genotypes (1.5-1.8 times), and the lowest - in *K-7907* genotype (1.2 times).

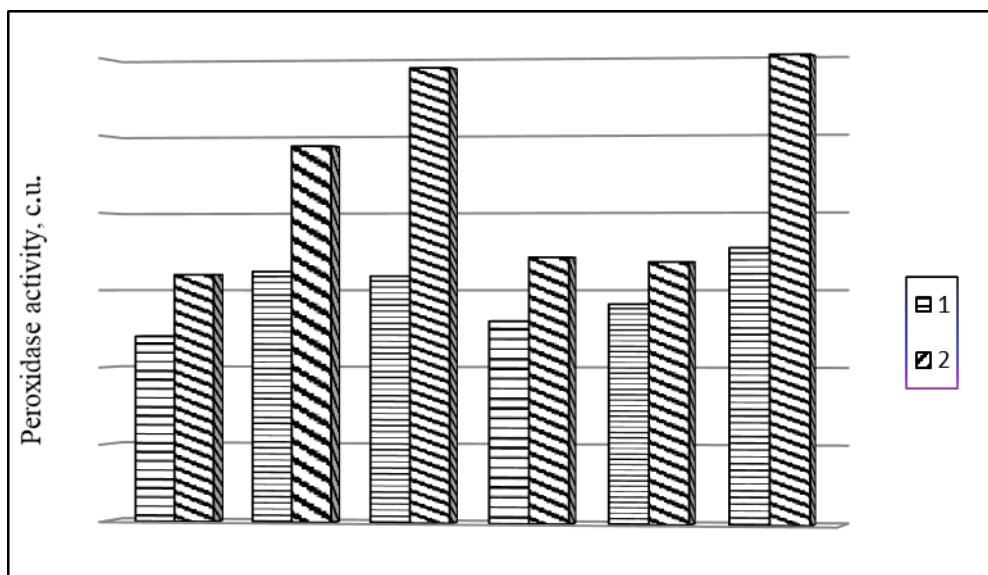


Figure 3. Change in the activity of the enzyme peroxidase in flax seed roots after accelerated aging. 1 – Control; 2 – Experiment. Evaluation genotypes: 1 - Vizit; 2 - Batist; 3 -Belinca; 4 - Polesskiy-6; 5 - K-7907; 6 - Kaufmann.

According to the sum of different morphophysiological and biochemical parameters of flax seeds and seedlings, it can be concluded that all samples of the collection have a high storage potential and are resistant to abiotic environmental factors. The flax genotypes *K-7907* and *Batist* had the highest storage potential. All the flax samples studied can be deposited in the Plant Genetic Bank for *ex situ* conservation.

Conclusions

Another air temperature during accelerated aging for some flax genotypes - 43°C - was proposed and tested.

The test of accelerated ageing of seeds allows to determine their storage potential, which makes it possible to characterise the ability of samples of different crops for long-term *ex situ* conservation in the genetic bank of plants.

All flax genotypes studied have a high storage potential and are suitable for long-term storage in active collections of the gene bank.

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