TRENDS IN TOTAL LIPID CONTENT OF PEA SEEDS UNDER STORAGE CONDITIONS

EVOLUȚIA CONȚINUTULUI TOTAL DE LIPIDE DIN SEMINȚELE DE MAZĂRE ÎN CONDIȚII DE DEPOZITARE

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Abstract.
Crop plant seeds deteriorate when stored improperly and for long periods. Thus, there is a loss of growth and vigor of aged seeds, which eventually leads to a decrease in total germ count. The decrease in vigor of young plants depends on the storage conditions, the crop species and the cultivar play a major role. Relative humidity and storage temperature are the major factors. that influence seed quality during storage. Seed deterioration is caused by loss of carbohydrate, protein, lipid, etc. Content in order to reveal the losses in lipid content, during 2017-2019, four garden pea cultivars stored under different temperature and humidity conditions were analyzed in triplicate. The obtained results highlight that lipids are influenced by both storage conditions and seed age. The data show a higher propensity to depreciation of the cultivar Gloriosa compared to Zsuzsi or Kelvedon Wonder, which denotes a better genetic capacity of both cultivars to adapt to storage conditions. The best results were obtained when seeds of these cultivars were stored at 4 °C and 8% humidity compared to 22 °C and 65% humidity.
Key words: pea seed, cultivars, storage conditions, seed deterioration

Rezumat.
Semințele plantelor de cultură se deteriorează atunci când sunt depozitate necorespunzător și pentru perioade lungi. Astfel, se produce o pierdere a creșterii și a vigorii semințelor îmbătrânite, ceea ce duce în cele din urmă la o scădere a numărului total de germeni. Scăderea vigorii plantelor tinere depinde de condițiile de depozitare, specia de cultură și soiul. Umiditatea relativă și temperatura de depozitare sunt principalii factori care influențează calitatea semințelor în timpul depozitării. Deteriorarea semințelor este cauzată de pierderea de carbohidrați, proteine, lipide etc. Pentru a evidenția pierderile în conținutul de lipide, în perioada 2017-2019, au fost analizate în triplicat patru cultivare de mazăre de grădină depozitate în condiții diferite de temperatură și umiditate. Rezultatele obținute evidențiază faptul că lipidele sunt influențate atât de condițiile de depozitare, cât și de vârsta semințelor. Datele arată o propensiune mai mare la depreciere a cultivarului Gloriosa comparativ cu Zsuzsi sau Kelvedon Wonder, ceea ce denotă o capacitate genetică mai bună a celor

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două cultivaruri de a se adapta condițiilor de depozitare. Cele mai bune rezultate au fost obținute atunci când semințele acestor cultivare au fost depozitate la 4 °C și 8% umiditate, comparativ cu 22 °C și 65% umiditate.

Cuvinte cheie: semințe de mazăre, cultivare, condiții de depozitare, deteriorarea semințelor

INTRODUCTION

Pea (*Pisum sativum* L.) is an annual vegetable plant of the *Fabaceae* family, native to southwest Asia. The plant is valued for the benefits it brings to the soil through its ability to fix atmospheric nitrogen, while the seeds are valued for their nutritional value, being an important source of plant protein, fiber, vitamins and minerals [Cojocaru *et al.*, 2024].

On average, pea seeds contain 55% starch and 23% protein [Sosulski and McCurdy, 1987]. As for the number of researches carried out in our country on lipid content of pea seeds, they are in very small number. Studies from other countries reported that lipid content in pea seeds ranged from 9% to 35% [Bastianelli *et al.*, 1998; Ryan *et al.*, 2007].

Saving vegetable seeds is an essential practice for farmers as it guarantees crop success. Depending on the vegetable species and storage conditions, seeds can be stored for long periods without losing germination or germination energy [Stefan *et al.*, 2013; Stoleru *et al.*, 2016].

The physiological ageing of seeds involves a series of degenerative changes leading to loss of viability. Ageing usually starts after physiological maturity, when the seed is qualitatively optimal. The major factors influencing the degree of aging are increased humidity and temperature during storage, both of which accelerate the rate of aging [Priestley *et al.*, 1986]. Physiological changes during aging include decreased enzyme activity, respiration, protein synthesis, lipid peroxidation and membrane damage [Coolbear, 1995]. The accelerated aging technique is commonly used as a method to determine the storage potential of seed lots and to assess their vigor [Delouche and Baskin, 1973]. Accelerated aging involves exposure of the seed to high humidity and temperature. Environmental conditions and exposure times that are effective for increasing the physiological age of seed can range from mild (25 to 30 °C, 75 to 94% RH for 6 to 24 weeks) to severe (45 °C, 100% RH for 1 to 8 days) [Delouche and Baskin 1973; Janusauskaite, 2023]. It is hypothesized that accelerated aging amplifies the deterioration processes that normally occur during prolonged storage [Delouche and Baskin, 1973] as the changes that occur during accelerated aging appear to be the same as those of natural aging [Chen *et al.*, 2023]. In addition, if a significant level of anaerobic respiration occurs during accelerated aging, for which by-products (ethanol) could be responsible. However, high levels of ethanol should accumulate in the seed before a significant decline in seedling vigor [Paulitz *et al.*, 1992].

The aim of the experiment was to evaluate the lipid content under storage conditions, age and cultivar influence.

MATERIALS AND METHOD

The experiment was carried out in the Laboratory of Vegetable Growing at the University for Life Sciences in Iasi, Romania. During the three years of experiments, four pea cultivars of Hungarian, Bulgarian, Italian and Dutch origin were used as biological material, which can react differently under specific growing conditions. The four pea cultivars (*Pissum sativum* L.) used in the experiment were: Zsuzsi, Gloriosa, Meraviglia and Kelvedon Wonder. Seed chemical analysis was performed at the biochemistry laboratory of the University for Life Sciences in Timisoara, Romania. The experimental protocol was based on the combination of three factors, three replicates were used for each combination of factors: Factor A - *the cultivar* had four graduations: a_1 - 'Zsuzsi'; a_2 - 'Gloriosa'; a_3 - 'Meraviglia'; a_4 - 'Kelvedon Wonder'; Factor B - the *crop year* had three graduations: b_1-'2017'; b_2-'2018'; b_3-'2019'; Factor C - *storage conditions* had five graduations: c_1-'SC_1-t=4^0C x U=8%'; c_2-'SC_2-t=4^0C x U=12%'; c_3-'SC_3-t=8^0C x U=8%'; c_4-'SC_4-t=8^0C x U=12%'; c_5-'SC_5-t=22^0C x U=65%'.

Results were reported as means ± standard error of the experiment for the three years (2017-2019), after processing the raw data by ANOVA and mean separation by Tukey's multiple range ($p \leq 0.05$) test ($p \leq 0.05$) using SPSS v21 software (IBM Corp, Armonk, NY, USA).

RESULTS AND DISCUSSIONS

Under storage conditions, seed metabolism is restricted, therefore it is likely that the aging reactions are randomly influenced. Studies on the effects of oxygen on seed deterioration and oxygen uptake by dry seeds [Fatokun *et al.*, 2020] suggest that the reactions may be oxidative. One of the most commonly cited hypotheses explaining seed deterioration points to lipid peroxidation as the mechanism by which cell membranes are subject to damage. There are many types of peroxidative reactions in which lipids serve as substrates, but the most commonly cited involve the breaking of the ester bond between the acyl and glycerol chain or the attack of the unsaturated bonds of the fatty acid chain. Results on lipid dynamics in pea seeds for the three years of storage are presented in Table 1.

The data in Table 1 highlight that lipids are influenced by storage conditions and age. The lipid content ranged within quite wide limits, from 23.37 $g \cdot 100\ g^{-1}$ d.w. in the case of cultivar Gloriosa harvested in 2017 and stored under normal atmospheric conditions to 31.86 $g \cdot 100\ g^{-1}$ d.w. in the case of cultivar Zsuzsi harvested in 2019 and stored under optimal temperature and humidity conditions, the difference of 36.33% being highly statistically significant ensured.

Significantly superior results are observed especially in the case of low-aged seeds, which means that they will have a favorable effect on the vigor of future plants with favorable repercussions on the yield capacity. Seed age is an important biological factor on which seed vigor depends. In general, old seeds lose their vigor rapidly, mostly due to primary metabolites.

Figure 1 shows the results on the influence of 4 °C temperature and 8% moisture on lipid content of pea seeds in the three years of experiments (2017, 2018 and 2019). The lipid content ranged from 27.62 $g \cdot 100\ g^{-1}$ d.w. in the seeds of cultivar Gloriosa in 2017 to 31.86 $g \cdot 100\ g^{-1}$ d.w. in the seeds of cultivar Zsuzsi in 2019.

Table 1

Influence of storage conditions of garden pea seeds on lipid content (g·100 g^{-1} d.w.)

Experimental factor		Storage conditions				
		SC$_1$	**SC$_2$**	**SC$_3$**	**SC$_4$**	**SC$_5$**
Zsuzsi	2017	28.19±2.07	27.26±2,00	27.71±2.03	25.74±1.89	23.85±1.75
	2018	31.11±2.28	30.08±2.2	30.58±2.24	28.4±2.08	26.32±1.93
	2019	**31.86±2.34**	30.81±2.26	31.32±2.3	29.09±2.13	26.95±1.98
Gloriosa	2017	27.62±2.02	26.71±1.96	27.15±1.99	25.22±1.85	**23.37±1.71**
	2018	30.47±2.23	29.46±2.16	29.95±2.2	27.82±2.04	25.78±1.89
	2019	31.21±2.29	30.18±2.21	30.68±2.25	28.49±2.09	26.4±1.94
Meraviglia	2017	27.67±2.03	26.76±1.96	27.2±1.99	25.26±1.85	23.41±1.72
	2018	30.53±2.24	29.52±2.16	30.01±2.2	27.87±2.04	25.83±1.89
	2019	31.27±2.29	30.24±2.22	30.74±2.25	28.55±2.09	26.45±1.94
Kelvedon Wonder	2017	27.76±2.03	26.84±1.97	27.29±2	25.34±1.86	23.48±1.72
	2018	30.63±2.25	29.62±2.17	30.11±2.21	27.97±2.05	25.91±1.9
	2019	31.37±2.3	30.33±2.22	30.84±2.26	28.64±2.1	26.54±1.95

SC$_1$- (t=4^{0}C x U=8%); SC$_2$- (t=4^{0}C x U=12%); SC$_3$- (t=8^{0}C x U=8%); SC$_4$- (t=8^{0}C x U=12%); SC$_5$- (t=22^{0}C x U=65%)

Figure 2 shows the results on the influence of 4 °C temperature and 12% humidity on lipid content of pea seeds in the three years of experiments (2017, 2018 and 2019). The lipid content ranged from 26.71 g·100 g^{-1} d.w. in seeds of the cultivar Gloriosa in 2017 to 30.81 g·100 g^{-1} d.w. in seeds of the cultivar Zsuski in 2019.

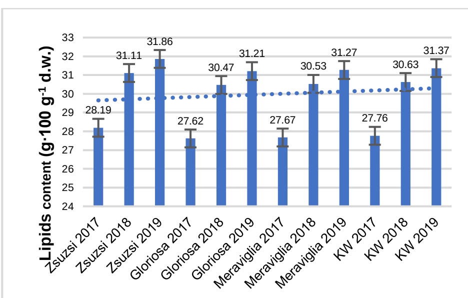

Fig. 1. Results on the influence of pea seed storage conditions (t=4^{0}C x U=8%) on lipid content

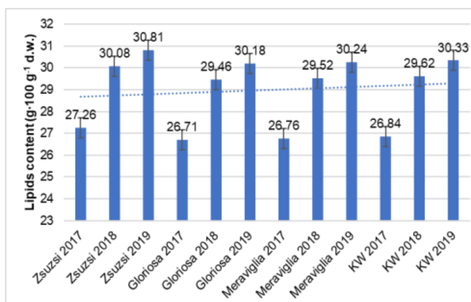

Fig. 2. Results on the influence of pea seed storage conditions (t=4^{0}C x U=12%) on lipid content

Figure 3 shows the results on the influence of 8^{0}C temperature and 8% moisture on lipid content of pea seeds in the three years of experiments (2017, 2018 and 2019). The lipid content ranged from 27.15 g·100 g^{-1} d.w. in the seeds of cultivar Gloriosa in 2017 to 31.32 g·100 g^{-1} d.w. in the seeds of cultivar Zsuski in 2019.

Figure 4 shows the results on the influence of 8 °C temperature and 12% moisture on lipid content of pea seeds in the three years of experiments (2017, 2018 and 2019). The lipid content ranged from 25.22 g·100 g^{-1} d.w. in seeds of the cultivar Gloriosa in 2017 to 29.09 g·100 g^{-1} d.w. in seeds of the cultivar Zsuski in 2019.

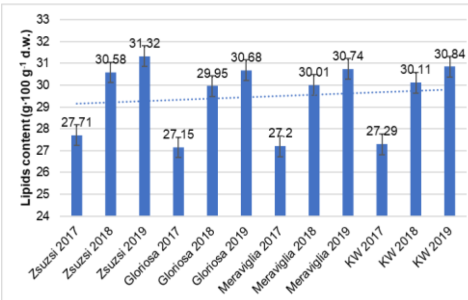

Fig. 3. Results on the influence of pea seed storage conditions (t=8^{0}C x U=8%) on lipid content

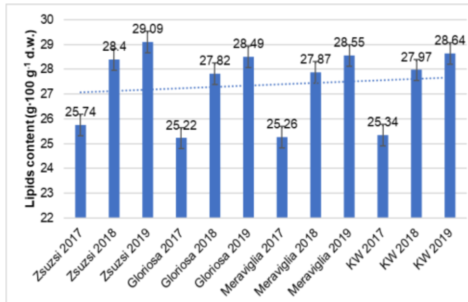

Fig. 4. Results on the influence of pea seed storage conditions (t=8^{0}C x U=12%) on lipid content

Figure 5 shows the results on the influence of 22^{0}C temperature and 65% humidity on the lipid content of pea seeds in the three years of experiments (2017, 2018 and 2019). The lipid content ranged from 23.37 g·100 g^{-1} d.w. in seeds of the cultivar Gloriosa in 2017 to 26.95 g·100 g^{-1} d.w. in seeds of the cultivar Zsuski in 2019.

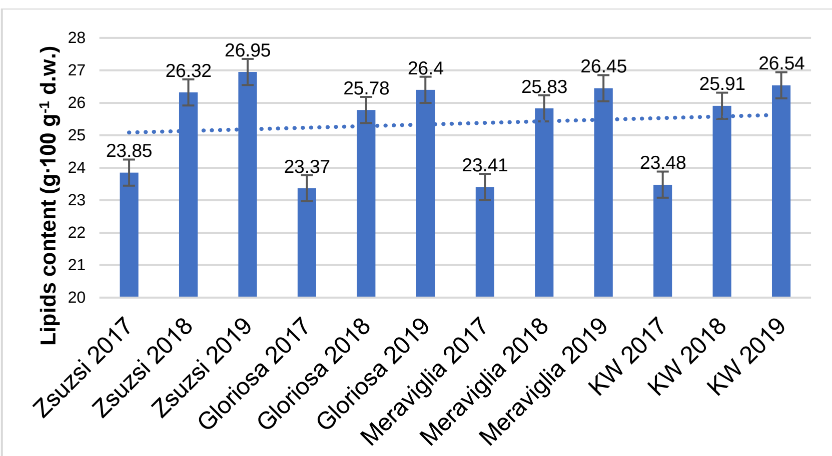

Fig. 5. Results on the influence of pea seed storage conditions (t=22^{0}C x U=65%) on lipid content.

CONCLUSIONS

The present study confirms that seed storage management as a function of temperature and humidity can significantly influence seed lipid content.

The finding that there were variations in lipid content indicates that the method of seed storage has statistical significance.

Seed age and storage temperature are the main factors in pea seed storage with regard to lipid content.

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