Influence of Storage Condition on Seed Oil Content of Maize, Soybean and Sunflower

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Summary

The study was aimed to examine the changes in seed oil content in different genotypes of maize, soybean and sunflower from 2002 to 2006, in two types of storage conditions which differ in air temperature and humidity: 25°C/75% and 12°C/60%, respectively. Affected by storage longevity, in average, seed oil content decreased by 0.82% in maize, 2.19% in soybean and 8.53% in sunflower. Differences in oil content affected by storage longevity were significant among tested crops and genotypes within crops. Storage longevity was negatively associated with oil content. At storage conditions at 12°C/60%, decreasing of seed oil content was less by 0.55% (maize), 1.30% (soybean) and 1.75% (sunflower) than in storage conditions at 25°C/75%. In summary, the lowest seed quality losses were in maize, then in soybean and the highest losses were in sunflower. Decreasing of seed quality losses is possible with suitable storage conditions, particularly for soybean and sunflower.

Key words

oil content, genotypes, maize, soybean, sunflower, storage conditions, storage longevity

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Received: November 3, 2006 | Accepted: April 5, 2007

Introduction

Seed quality is a multiple criterion that encompasses several important seed attributes: genetic and chemical composition, physical condition, physiological germination and vigor, size, appearance and presence of seed-borne pathogens, crop and varietal purity, weed and crop contaminants and moisture content. During storage, seed quality can remain at the initial level or decline to a level that may make the seed unacceptable for planting purpose. This is related to many determinants: enivronment conditions during seed production, pests, diseases, seed oil content, seed moisture content, mechanical damages of seed in proccessing, storage longevity, packaging, pesticides, air temperature and relative air humidity in storage, biochemical injury of seed tissue and similar (Al-Yahya, 2001; Šimić et al., 2004; Guberac et al., 2003; Heatherly and Elmore, 2004). Storage longevity may vary from six months (usually for maize, soybean and sunflower), up to 20 months or longer if the seeds are to be carried over. Longevity of seed in storage is influenced by the initial quality of stored seed as well as storage conditions. Irrespective of initial seed quality, unfavourable storage conditions, particularly air temperautre and air relative humidity, contribute to acceleration of seed deterioration in storage. Hence, it's difficult to assess the effective storage period because the storability of the seed is a function of initial seed quality and the storage conditions (Wych, 1988; Fabrizius et al., 1999; Heatherly and Elmore, 2004). Intensity of quality decrease of stored seed is different among plant species and within plant species (genotypic variability), implying considerable influence of genetic (heritable) component on phenotypic expression of traits which determine seed quality (Al-Yahya, 2001; Guberac et al., 2003; Vieira et al., 2001). The objective of this study was to examine the changes in seed oil content in maize, soybean, and sunflower affected by storage longevity under two levels of storage conditions differed in terms of air temperature and relative air humidity.

Material and methods

This study was carried out from 2002 to 2006 at the Agricultural Institute Osijek (Croatia) using basic seed of three agricultural crops: maize, soybean and sunflower. Selected maize hybrids ('OSSK 596', 'OSSK 602'-FAO group 600), sunflower hybrids ('Fakir', 'Apolon'-middle-early) and soybean cultivars ('Tisa'-maturity group (MG) I; 'Kaja'-MG 0) are creations of the Institute. The testing began after harvest of sunflower, maize and soybean in 2002. Samples of dried, cleaned and processed seeds for each of tested crops were taken as follows: 2x500 kg for maize and soybean, and 2x200 kg for sunflower. Before storage, seed oil content of all tested genotypes were determined. Seed samples were packed in bags and stored separately in two small storages with controlled conditions: Storage 1– 75% relative air humidity; 25°C air temperature and Storage 2 – 60% relative air humidity, 12°C air temperature. After four years of storage, from both storages, average seed samples were taken from each genotype for laboratory analysis. Seed oil contents (% in absolutely dry matter-ADM) were determined by Nuclear Magnetic Resonance (NMR) analyzer. The obtained experimental data were statisticly processed using the Statistical Analysis System Version 8.2 computer program (SAS Institute, 1989).

Results and discussion

The means of seed oil content for tested genotypes of maize, soybean and sunflower before and after storage in both type of storages with results of statistical analysis are presented in Table 1. From the analysis of presented data, it is obvious that analyzed seed quality traits varied amongst tested agricultural crops as well as within crops (genotype variation), with statistically high significant differences ($P \leq 0.01$). The mean value of seed oil content before storage was 4.45% in maize, 23.29% in soybean and 50.55% in sunflower. After four years for both storages, average seed oil content was 3.63% in maize, 21.10% in soybean and 42.02% in sunflower. By comparison of the means of this trait before and after storage, greater decline of oil content was in sunflower (decreasing by 8.53%), than in soybean (by 2.19%) and maize (by 0.82%). Differences in seed oil content affected by storage longevity (between years of storage) were statistically highly significant ($P \leq 0.01$) and consistent with tested crops. In Storage 1 the average decrease of oil content was 1.10% in maize, 2.84% in soybean and 9.40% in sunflower. In Storage 2 the average decrease of oil content was 0.55% in maize, 1.54% in soybean and 7.65% in sunflower. It is obvious that changes in oil content were less significant in Storage 2 by 0.55% in maize, 1.30% in soybean and by 1.75% in sunflower than in Storage 1. Differences in the oil content affected by different storage conditions were highly significant at level of $P \leq 0.01$ during the same period of storage consistent with all tested crops. Analysis of variance showed that interaction between tested crops and examined storage longevity, and also between storage longevity and storage type were highly significant ($P \leq 0.01$).

The obtained results of this study showed that the effect of storage longevity is negative on level of seed oil content in maize, soybean and sunflower, with significant differences amongst these crops in intensity of decreasing quality of stored seed. Thus, on the average for both storages, decreasing of oil content was less in maize in relation with soybean and sunflower, suggesting higher stability of analyzed quality seed attributes during storage in maize than in both soybean and sunflower, respectively. At the same time, differences in seed deterioration between soybean and sunflower also existed, particularly in oil content. It could be connected with differences amongst crops in expression

Table 1. Seed oil content means (% in ADM) of tested genotypes of maize, soybean and sunflower regarding storage longevity (2002-2006) and storage conditions: S1 (25°C/75%); S2 (12°C/60%)

Crops	Genotype	Oil content in seed (% in ADM)	
		Storage 1	Storage 2
Begining of storage (2002)			
Maize	OSSK 596	4.70	4.70
	OSSK 602	4.20	4.20
Soybean	Tisa	23.18	23.18
	Kaja	23.40	23.40
Sunflower	Fakir	47.76	47.76
	Apolon	53.35	53.35
End of storage (2006)			
Maize	OSSK 596	3.50	4.00
	OSSK602	3.20	3.80
Soybean	Tisa	20.70	22.00
	Kaja	20.20	21.50
Sunflower	Fakir	42.10	43.20
	Apolon	40.20	42.60

Sources of variation	*F* test	LSD test	
		0.05	0.01
Crops (A)	59537.441**	0.238	0.328
Storage longevity (B)	7128.33**	0.071	0.093
Storage type (C)	35.020**	0.058	0.077

of the protective system of enzymatic and non-enzymatic processes which influence the intensity of seed deterioration. Thus, in oil crops, such as soybean and sunflower, autooxidation of lipids and increase of the content of free fatty acids during storage period are the main reasons for rapid deterioration of the oil seed as presented by Reuzeau and Cavalie (1995), Trawatha et al. (1995), and Balašević-Tubić et al. (2005). Longevity of stored seed of any crops considerably depends on the storage conditions, primarily in terms of air temperature and relative air humidity in storage. Results of our study showed that in the worst storage conditions (25°C/75%) were higher seed quality losses than in the storage with lower temperature and lower relative humidity (12°C/60%). These findings corresponded well to those reported elsewhere that unfavorable storage conditions (high air temperature and high humidity of air) accelerate seed deterioration, causing seed quality losses and therein lower germinability percentage of stored seed (Depaula et al., 1996; Al-Yahya, 2001).

Conclusion

In summary, data obtained in this study indicate that effect of storage longevity on seed oil content is more or less negative and considerably affected by storage conditions. If suitable storage conditions are not, provided, quality and quantity losses increase. Decreasing these losses is possible providing suitable storage conditions and storage management, what enables the preserving seed quality attributes, such as seed oil content, on the satisfactory level acceptable for production purposes. Furthermore, over the same storage period and under same storage conditions, the intensity of seed quality declining is different among plant species due to genetic diversity, which implies the importance of creating suitable storage conditions according to crop that will be stored.

References

Al-Yahya, S.A.(2001): Effect of Storage Conditions on Germination in Wheat. Journal of Agronomy and Crop Science 186, 4, 273-279.

Balašević-Tubić, S., Đ. Malenčić, M. Tatić, J. Miladinović. (2005): Influence of aging process on biochemical changes in sunflower seed. Helia 28 (42), 107-114.

Depaula, M., M. Perezotaola, M. Darder, M. Torres, M. Frutos, G. Martinezhonduvilla (1996): Function of the ascorbate-glutathione cycle in aged sunflower seeds. Physiologia Plantarum 96 (4), 543-550.

Fabrizius, E., D. TeKrony, D. B., Egli, M. Rucker. (1999): Evaluation of a viability model for predicting soybean seed germination during warehouse storage. Crop Sci. 39, 194-201.

Guberac, V., S. Marić, A. Lalić, G. Drezner, Z. Zdunić. (2003): Hermetically Sealed Storage of Cereal Seeds and its Influence on Vigor and Germination. Journal of Agronomy and Crop Science 189, 54-56.

Heatherly, L.G. and R.W. Elmore. (2004): Managing Inputs for Peak Production. In: Soybeans: Improvement, Production and Uses eds by Boerma H.R. and Specht, J.E.. 3rd Edition, Agronomy N-16, ASA, CSSA, SSSA, Madison, Wisconsin, USA, 451-536.

Reuzeau, C. and G. Cavalie. (1995): Activities of free radical processing enzymes in dry sunflower seeds. New Phytol. 130, 59-66

Šimić B., S. Popović, M. Tucak. (2004): Influence of corn (Zea mays L.) inbred lines seed processing on their damage. Plant, Soil and Environment 50 (4), 157-161.

Tekrony, D.M., C. Nelson, D.B. Egli, G.M. White. (1993): Predicting soybean seed germination during warehouse storage. Seed Science and Technology 21 (1), 127-137.

Trawatha, S.E., D.M. TeKrony, D.F. Hildebrand. (1995): Relationship on soybean quality to fatty acid and C6-aldehyde levels during storage. Crop Sci. 35, 1415-1422.

Vieira , R.D., D.M. TeKrony, D.B. Egli, M. Rucker. (2001): Electrical conductivity of soybean seeds after storage in several environments. Seed Science and Technology 29, 599-608.

Wych, R.D. (1988): Production of Hybrid Seed Corn. In: Corn and Corn Improvement eds by G.F. Sprague and J. W. Dudley. Agronomy N-18, Madison, Wisconsin, USA, 565-607.

Zanakis, G.N., R.H. Ellis, R.J. Summerfield. (1993): Response of seed longevity to moisture content in three genotypes of soybean (Glycine max). Experimental Agriculture 29 (4), 449-459.

*** Association of Official Seed analysis, (1983): Seed vigor testing handbook, no. 32, AOSA

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