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ABSTRACT
Storage temperature and relative humidity (r.h.), as the most important variable factors, influence seed changes which lead to its quality deterioration. Quantitative relation between storage factors and seed viability deterioration were investigated in various papers. Our investigations proved that wheat and maize grain temperature changed depending on temperature and r.h. in storage facilities during the first 34 days of storing. At the temperature of 0°C and r.h. of 55%, 73%, 80% and 98% wheat grain temperature decreased, as following, 8.12°C, 8.05°C, 9.38°C and 7.58°C but at the temperature of 20°C and r.h. of 55%, 73%, 80% and 98% wheat grain temperature increased, as following, 11.08°C, 11.08°C, 10.05°C and 11.30°C, after 34 days storage period. At the temperature of 0 °C and relative humidity of 55%, 73%, 80% and 98% maize grain temperature decreased, as following, 8.5 °C, 8.05°C, 7.58°C and 7.1°C but at the temperature of 20°C and r.h. of 55%, 73%, 80% and 98% maize grain temperature increased, as following, 9.25°C, 9.5°C, 9.45°C and 10.23°C, after 34 days storage period. Concerning significant differences in grain temperature alteration at both species, we assume that it reflect on grain viability of investigated species.

Key words: grain temperature, wheat, maize, storage temperature, relative humidity, viability

INTRODUCTION
Storage temperature and relative humidity, as the most important variable factors, influence seed changes which lead to its quality deterioration. Quantitative relation between storage factors and seed viability deterioration were investigated in various papers. One of the first authors who tried to confirm this quantitative relation was Groves [1], concerning wheat viability and temperature periods. Later, in many other papers influence of the grain moisture and temperature was included in equation. There has been suggested an equation Roberts [2] that described interrelationship among temperature, grain moisture content and grain viability in the best way:

$$\log p50 = Kv - C_1 m - C_2 t$$

where is p50 = time needed for viability loss in 50% of grain, m = moisture content, t=temperature (°C), Kv, C_1 and C_2 = constants. By applying the same equation, Harington [3] found out two principles still in use that decrease influence of the

moisture and temperature to the grain deterioration. The first says that each decreased percentage of grain moisture level prolongs life of stored grain twice. The second says that each decreased 5 °C of the grain temperature prolongs life of the stored grain twice. Apart from these factors, grain germination depends on species, cultivar, and even on the grain category.
As a new approach, for the purpose of seed quality preservation during storing, a computer program, expert system (ES) has been suggested, Fleurat-Lessard [4]. It is knowledge based (KB) system, which refers to attributes that change very early in unsafe storage conditions. Thus, causes of stock quality deterioration could be removed on time.

MATERIAL AND METHODS

Grain wheat ("Žitarka" cultivar) and maize (OSSK 44 hybrid) were used in the bioassay. 8 kg of each species were divided into 32 bags, four samples for measuring relative humidity and four for measuring temperature. Each sample weighing 250 g was placed into a linen bag and sealed.
Four samples of the single cultivar were placed into a tightly sealed plastic container. Containers were maintained at the four regimes of relative humidity, as follows, 55%, 73%, 80% and 98%, and at two regimes of temperature, 0 °C and 20 °C, as follows. So, each bioassay variant included two cultures in four replications. Favourable values of relative humidity were gained by applying saturated solution of NaCl (73%) and urea (80%), and with desaturated solution of NaCl (98%), and silica gel (55%). Bioassay was set at the Department for grain production and nurseries in Osijek, Croatia, during 34 days in 2005 and 2006. Each seven days in this period, changes in seed temperature and the data obtained were subjected to analysis of variance and LSD test.

RESULTS AND DISCUSSION

1.1. Wheat - results of grain temperature at 0 °C storage

At the temperature of 0 °C and r.h. of 55%, 73%, 80% and 98% wheat grain temperature decreased, as following, 8.12 °C, 8.05 °C, 9.38 °C and 7.58 °C, after 34 days storage (Figure 1).

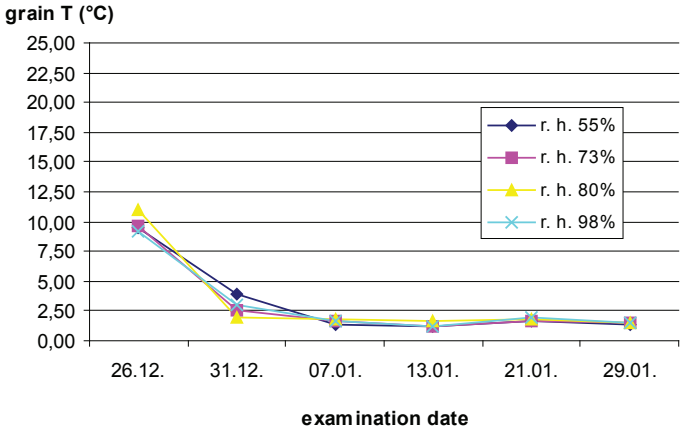

Figure 1. Wheat – grain temperature (°C) at 0 °C

Analysis of variance (Table 1) and LSD test (Table 2) proved significant differences in decreasing seed temperature of wheat at different relative humidities and 0 °C temperature already at the first six days of the 34 days storage.

Table 1. Wheat grain temperature (°C) at storage temperature of 0 °C

r.h.%	Treatments (examination date)					
	26.12. 2005.	31.12. 2005.	07.01. 2006.	13.01. 2006.	21.01. 2006.	29.01. 2006.
55%	9.52	3.97	1.35	1.17	1.65	1.40
73%	9.63	2.55	1.70	1.23	1.70	1.58
80%	10.93	1.92	1.83	1.65	1.80	1.55
98%	9.13	2.95	1.70	1.20	1.90	1.55
Average	9.80	2.85	1.64	1.31	1.76	1.52
F test 179.1808** Lsd test Lsd0,05=0.7331 Lsd0,01=1.0043						

Table 2. LSD test – wheat grain temperature at 0 °C

examination date	26.12.	31.12.	07.01.	13.01.	21.01.	29.01.
26.12.	-	19.91**	23.38**	24.32**	23.03**	23.72**
31.12.		-	3.43**	4.41**	3.12**	3.81**
07.01.			-	0.94*	0.34	0.35
13.01.				-	1.28**	0.60
21.01.					-	0.68
29.01.						-

* - significantly differences by Lsd-test; ** - highly significantly differences by Lsd- test

1.2. Wheat - results of grain temperature at 20°C storage

At the temperature of 20 °C and r.h. of 55%, 73%, 80% and 98% wheat grain temperature increased, as following, 11.08 °C, 11.08 °C, 10.05 °C and 11.30 °C, after 34 days storage period (Figure 2).

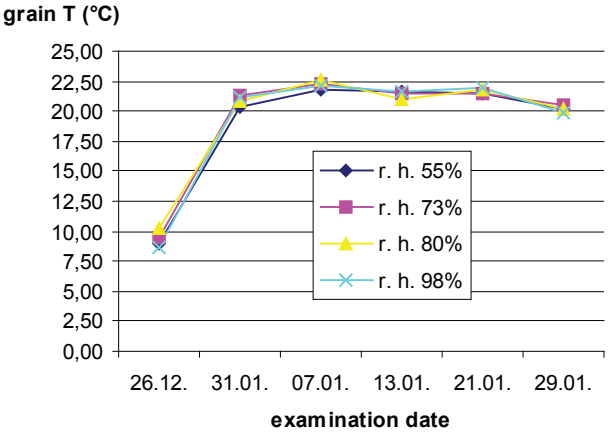

Figure 2. Wheat – grain temperature (°C) at 20 °C

Analysis of variance (Table 3) and The LSD test (Table 4) showed high significant differences in temperature increasing in wheat grain already at the first six days of the 34 days storage.

Table 3. Wheat grain temperature (°C) at storage temperature of 20 °C

r.h.%	Treatments (examination date)					
	26.12.2005.	31.12.2005.	07.01.2006.	13.01.2006.	21.01.2006.	29.01.2006.
55%	9.05	20.40	21.80	21.70	21.52	20.13
73%	9.40	21.25	22.27	21.42	21.48	20.48
80%	10.20	20.90	22.67	20.92	21.85	20.25
98%	8.65	21.13	22.08	21.58	21.98	19.95
Average	9.33	20.92	22.21	21.41	21.71	20.20
F test: 624.558** Lsd test: Lsd0,05=0.5863 Lsd0,01=0.8032						

Table 4. LSD Test – wheat grain temperature at 20°C

examination date	26.12.	31.12.	07.01.	13.01.	21.01.	29.01.
26.12.	-	41.54**	46.16**	43.29**	44.37**	38.96**
31.12.		-	4.62**	1.75**	2.83**	2.58**
07.01.			-	2.80**	1.79**	7.20**
13.01.				-	1.07**	4.33**
21.01.					-	5.41**
29.01.						-

*** - highly significantly differences by Lsd- test*

2.1. Maize - results of grain temperature at 0 °C storage

At the temperature of 0 °C and relative humidity of 55%, 73%, 80% and 98% maize grain temperature decreased, as following, 8.5 °C, 8.05 °C, 7.58 °C and 7.1 °C, after 34 days storage (Figure 3).

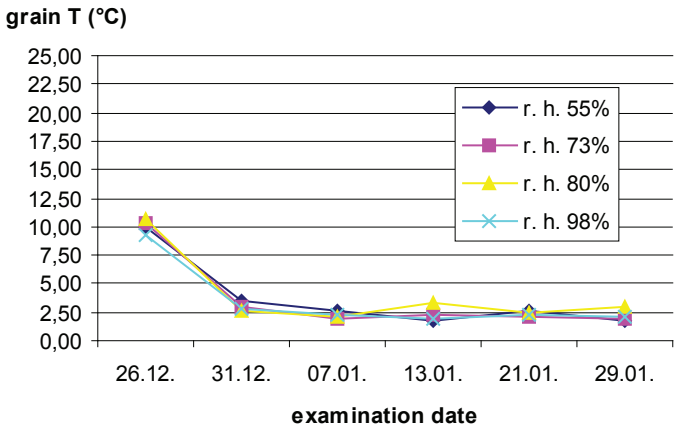

Figure 3. Maize – grain temperature (°C) at 0 °C

Analysis of variance (Table 5) and LSD test (Table 6) showed high significant differences in temperature increasing in maize grain already at the first six days of the 34 days storage.

Table 5. Maize grain temperature (°C) at storage temperature of 0 °C

r.h.%	Treatments (examination date)					
	26.12.2005.	31.12.2005.	07.01.2006.	13.01.2006.	21.01.2006.	29.01.2006.
55%	9.95	3.53	2.63	1.73	2.70	1.83
73%	10.38	3.05	1.90	2.28	2.15	1.88
80%	10.63	2.55	2.03	3.25	2.53	3.05
98%	9.32	2.80	2.30	1.95	2.22	2.15
Average	10.07	2.98	2.21	2.30	2.40	2.22
F test 163.569** Lsd test Lsd0,05=0.7281 Lsd0,01=0.9974						

Table 6. LSD Test – maize grain temperature at 0 °C

examination date	26.12.	31.12.	07.01.	13.01.	21.01.	29.01.
26.12.	-	20.43**	22.65**	22.39**	22.10**	22.62**
31.12.		-	2.21**	1.95**	1.67**	2.19**
07.01.			-	0.25	0.57	0.02
13.01.				-	0.28	0.23
21.01.					-	0.51
29.01.						-

** - highly significantly differences by Lsd- test

2.2 Maize - results of grain temperature at 20 °C storage

At the temperature of 20 °C and r.h. of 55%, 73%, 80% and 98% maize grain temperature increased, as following, 9.25 °C, 9.5 °C, 9.45 °C and 10.23 °C, after 34 days storage period (Figure 4).

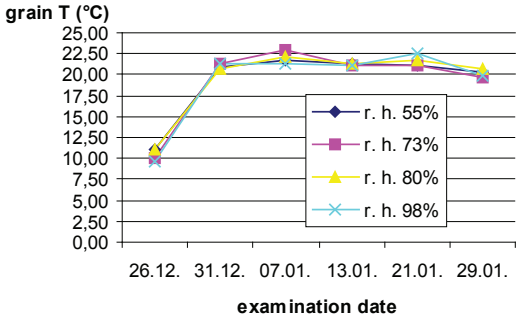

Figure 4. Maize – grain temperature (°C) at 20 °C

Analysis of variance (Table 7) and the LSD test (Table 8) showed high significant differences in temperature increasing in maize grain already at the first six days of the 34 days storage.

Table 7. Maize grain temperature (o C) at storage temperature of 20 °C

r.h.%	Treatments (examination date)					
	26.12.2005.	31.12.2005.	07.01.2006.	13.01.2006.	21.01.2006.	29.01.2006.
55%	10.98	20.98	21.63	21.27	21.02	20.23
73%	10.13	21.25	22.98	21.10	21.10	19.63
80%	11.15	20.77	22.17	21.27	21.70	20.60
98%	9.57	21.27	21.38	21.05	22.60	19.80
Average	10.46	21.07	22.04	21.17	21.61	20.06
F test: 256.0304** Lsd test: Lsd0,05=0.8229 Lsd0,01=1.1272						

Table 8. LSD Test – maize grain temperature at 20 °C

examination date	26.12.	31.12.	07.01.	13.01.	21.01.	29.01.
26.12.	-	27.06**	29.54**	27.32**	28.44**	24.48**
31.12.		-	2.47**	0.25	1.37**	2.57**
07.01.			-	2.21**	1.09*	5.05**
13.01.				-	1.12*	2.83**
21.01.					-	3.95**
29.01.						-

* - significantly differences by Lsd-test; ** - highly significantly differences by Lsd- test

Many empirical studies have been carried out referring to the influence of temperature and r.h. to the grain viability. It is determined that wheat grain viability rapidly decreases under higher temperatures in relation to the lower storage temperatures Al-Yahya [5]. For the purpose of maize grain viability prediction during storing, a model with effective viability prediction was developed under temperature range of 30 °C – 50 °C. In most cases lower temperature and lower r.h. proved to prolong grain viability. Our investigations were done on the species proving the principle that longer grain viability required lower values of temperature, r.h. and oxygen in grain pore space.

CONCLUSION

These investigations proved that wheat ("Žitarka" cultivar) grain temperature and maize (OSSK 644 hybrid) grain temperature changed depending on temperature (0 °C and 20 °C) and r.h. (55%, 73%, 80% and 98%) in storage facilities during the first 34 days of storing. Concerning significant differences in grain temperature alteration at both species, we assume that it reflect on grain viability of investigated species. Additional investigations are necessary for precise definition of grain temperature influence on these species germination and viability.

REFERENCES

1. Groves, J.F. 1917. Temperature and life duration of seeds. Bat. Gaz., 63: 169 – 89.
2. Roberts, E.H. 1960. The viability of cereal seed for brief and extended periods. Ann. Bot., 24: 12 – 31.
3. Harington, J.F. 1963. Practical advice and instruction on seed storage. Proc. Int. Seed test. Ass., 28: 989 – 64.
4. Fleurat-Lessard, F. 2002. Qualitative reasoning and integrated management of the quality of stored grain: a promising new approach. Journal of Stored Products Research 38, 191-218.
5. Al-Yahya S.A. 2001. Effect of storage conditions on germination in wheat. Journal of Agronomy & Crop Science-Zeitschrift fur Acker und Pflanzenbau. 186(4): 273-279.