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Optimization of storage conditions of new Lithuanian potato cultivars

ABSTRACT. In 2001–2003 studies of different storage temperatures influence on the productivity of potato tuber and chips took place at the Lithuanian University of Agriculture. Four potato cultivars were studied: Vokė, Liepa, Venta and Vaiva. The amounts of dry matter, starch, total and reducing sugars, and solanine content were established on the basis of cultivar characteristics and storage temperature. The smallest losses of dry matter and starch were determined correspondingly in cv. Vaiva and Vokė potato tubers. The losses of total and reducing sugars fluctuated more in Liepa and Venta potato tubers. The increase of solanine was more intensive in the highest storage temperature in 'Liepa' potato tubers. After 7 months of storage potatos of Vokė cultivar are recommended for processing to good quality chips. Liepa, Vaiva and Venta cultivars are not suitable for this production.

KEY WORDS: potato, cultivars, storage temperature, chemical composition, quality of chips

The interest in potato chips production has been the most popular lately in Lithuania. The products are made almost all year round, so there is a necessity to store a potato as a raw for processing. During storage the tubers chemical composition changes – there is continuous physiological process having an important influence on quality of raw and processing products. The potato storage temperature is the most important factor for quality. So, the establishment of the optimal storage regime is very important for successful processing.

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The losses of dry matter are larger when storage temperature is higher. The potato genetic properties have influence on the amount of losses. If the storing temperature is 4–6°C, after seven-month storage the losses of dry matter fluctuate from 6.5% to 10% and if the storage temperature is 1 -3°C they reach 0.7–5.2%. The losses of starch amount during storage time depend on storage temperature too. If the temperature is 4-6°C, the losses fluctuate from 6.6% to 10.3%, if the temperature is 1–3°C they are by 0.5–5.0% less [Sowa-Niedziałkowska 1997].

The change of various sugar forms in potato tubers during storage has an important influence on quality of chips. The mentioned processed products have higher quality when the amount of sugars in tubers is lower because of smaller amounts of major compounds – melanoids. In conclusion – the taste and the appearance of products are better [Frydrecka-Mazurczyk, Zgórska 1996a]. The intensity of melanoid compound process depends on potato biological properties. The difference between potato cultivars are most exposing when they are stored for a longer time at low temperature – the amount of reducing sugars is twice as much [Pęksa 1994].

The glycoalkaloids chaconine and solanine in potato tubers occur as the products of intermediate metabolism. The human nervous system is toxically influence when the amount of solanine in potato tubers is more than 200 mg kg^{-1}. The synthesis of solanine during storage time in different temperature and lighting conditions differs intensively. The higher storage temperature is accompanied by the more intensive synthesis of metabolism production in potato tubers [Frydrecka-Mazurczyk, Zgórska 1996b, 1999].

The aim of our research was to determine the influence of different storage regimes on chemical composition changes, physiologic state of potato tubers and quality of chips.

METHODS

There have been investigated the Lithuanian potato cultivars: medium early Vokė and very early – Liepa, Venta and Vaiva, grown at Vokė Research Station of Lithuanian Institute of Agriculture (Vilnius Region).

The field soil trial at Vokė Research Station has been set on cal (ar)I-Endo–hypogleyic Luvisol, pH_{KCl} – 5.0–6.0, Org.C content – 2.0–2.2%, hydrolytic acidity – 19–44 g kg^{-1} of soil. The universal complexes of chlorine free fertiliser with microelements (10:10:20) $N_{70}P_{70}K_{140}$ was strewed in spring.

After harvest all potatoes were stored two weeks at 15°C temperature for treatment of wounds. After that all potato cultivars are stored for 7 months in

different temperature regimes: at 3– 4ºC, 7–8ºC and 9–10ºC, 86–95% RH in plastic 120 μ thickness bags of 8–10 kg. Total and natural losses have been determined once at two months by four replicates.

The mean samples for the chemical analysis are completed from 50 tubers. The chemical composition of potato tubers has been established by standardization methods as follow: content of dry matter, starch, total and reducing sugars and solanine.

The quality of chips has been determined by 5 point scales [Lisinska 1992]. The research data has been worked up statistic method. The correlation between the amount of solanine, reducing sugars and taste of chips has been determined by calculation of coefficients of correlation and determination [Tarakanovas 1996].

Results

The mean experimental results of 2001–2003 show that potato tubers, stored for 7 months at 3–4ºC temperature have considerably smaller dry matter losses than potatoes stored at 7–8ºC and 9–10ºC temperatures. The biggest losses of dry matter in potatoes, stored at 3–4ºC were found in cultivar Liepa. The amount of dry matter was 3.15 % smaller than that in the beginning at storage period. The smallest losses of dry matter amount have been determined in 'Vaiva' cultivar – correspondingly 2.88% (Tab. 1). The biggest losses of dry matter amount have been suffered by Venta and Liepa cultivars potatoes, stored for 7 months in 7–8ºC and 9–10ºC, correspondingly 5.81% and 6.82%. The smallest losses of the dry matter in the same temperature have been determined in 'Vokė' potato cultivar, correspondingly 4.60% and 6.42% (Tab. 1). Sowa G. [1988] has got the similar conclusion. According her the amount of dry matter losses depends on storage temperature, time and cultivar.

Table 1. Influences of storage temperature on the amount of dry matter and starch in potato tubers

Cultivar	After 7 months							
	dry matter				starch			
	Storage temperatures, ºC							
	after harvest	3–4	7–8	9–10	after harvest	3–4	7–8	9–10
	%							
Vokė	22.39	19.42	17.79	15.97	16.65	15.07	13.88	11.77
Liepa	21.27	18.12	15.88	14.45	15.70	13.60	12.02	11.20
Venta	19.17	16,06	13.36	12.53	13.73	11.55	9.79	9.20
Vaiva	19.39	16.51	14.15	12.94	13.72	11.48	10.74	9.44
$LSD_{0.05}$	2.21	2.03	2.00	3.10	1.05	1.30	1.00	2.00

Table 2. Influence of storage temperature on the amount of total and reducing sugars in potato tubers

Cultivar	After 7 months							
	total sugars				reducing sugars			
	Storage temperatures, °C							
	after harvest	3–4	7–8	9–10	after harvest	3–4	7–8	9–10
	%							
Vokė	0.47	0.65	0.44	0.40	0.15	0.48	0.23	0.24
Liepa	0.80	1.01	0.61	0.56	0.37	0.51	0.38	0.34
Venta	0.42	0.73	0.40	0.34	0.16	0.52	0.28	0,27
Vaiva	0.77	0.67	0.65	1.00	0.54	0.49	0.47	0.34
$LSD_{0.05}$	0.30	0.27	0.20	0.20	0.02	0.06	0.03	0.02

It has been noticed that the biggest losses of starch amount after 7 months in 3–4°C temperatures have been determined in cultivar Vaiva, and smallest – in cultivar Vokė, correspondingly 2.24% and 1.58%. Considerably bigger losses of starch amount have been observed in all potato cultivars stored 7 months at 7–8°C and 9–10°C. The larger losses of starch amount have been determined correspondingly in the cultivars of Venta (3.94%) and Vokė (4.88%) at 9–10°C storage temperature. The slowest disintegration of starch at 7–8°C storage temperature is in Vokė and Vaiva cultivars, correspondingly 2.77% and 4.28% (Tab. 1).

The experimental results show that the amount of total sugar constantly increase after 7 storage months at 3–4°C storage temperature. At the end of the experimental storage time the biggest amount of total sugars was determined in Venta potato tubers – it has increased by 0.31% (Tab. 2). The slightest changes of the amount of total sugar at the same temperature have been determined in cultivar of Vaiva – it has decreased by 0.10%. According to the data the biggest decrease of total sugar amount in storage period at 7–8°C and 9–10°C temperatures was in Liepa cultivar – it has changed correspondingly by 0.21% and 0.24% (Tab. 2).

The resembling changes have been determined in the amount of reducing sugars. The biggest increase, when potatoes are stored at 3–4°C, was in Venta potato tubers – 0.36%. The most intensive changes of reducing sugars amount at 7–8°C and 9–10°C have been determined in cultivar of Venta and Vokė, 0.08% and 0.09% correspondingly (Tab. 2). The process can be explained as follows: the calm period is over, physiological process gets more active, so for maintaining this process the increase of reducing sugars glucose and fructose is necessary [Pęksa 1994]. The dynamics of solanine synthesis shows that in first three months of storage at 3–4°C temperature the amount of glycoalkaloid decreases and later, depending on cultivar characteristics, increases. The synthesis of so-

lanine is more intensive in the potato tubers stored at 3–4°C temperatures. The quickest synthesis of solanine after 7 months storage is determined in all storage temperatures in Venta cultivar potato tubers – 15.9 mg kg^{-1}, 57.3 mg kg^{-1} and 67.4 mg kg^{-1}, correspondingly. The most intensive synthesis of the glycoalkaloid at 3–4°C storage temperature is determined in tubers of 'Vaiva' cultivar, at 7–8°C and – in Liepa potato tubers – at 9–10°C – 57.5 mg kg^{-1}, 80.5 mg kg^{-1} and 93.4 mg kg^{-1} correspondingly (Tab. 3).

Table 3. Influence of storage temperature on the amount of solanine in potato tubers

Cultivar	After harvest	After storage in months								
		3	5	7	3	5	7	3	5	7
		Storage temperatures, °C								
		3–4°C			7–8°C			9–10°C		
		mg kg^{-1}								
Vokė	41.7	35.0	44.0	64.3	44.2	67.4	99.1	46.9	82.7	119.2
Venta	53.5	50.9	63.5	69.4	59.2	74.0	110.8	66.3	93.6	120.9
Liepa	44.4	25.4	62.0	76.6	46.7	62.4	101.8	63.5	96.7	137.8
Vaiva	22.5	18.2	38.2	80.0	29.1	82.7	103.0	48.7	103.5	113.0
$LSD_{0.05}$	18.1	19.0	20.4	20.6	19.2	24.0	24.7	26.3	22.9	28.4

Table 4. The correlation between the amount of reducing sugars and solanine and the storage time of potato tubers

Storage time	Correlation coefficient (r_{xy})			Determination coefficient (%)		
	3–4°C	7–8°C	9–10°C	3–4°C	7–8°C	9–10°C
After harvest	0.320			10.2		
After 3 months	0.390	0.430	0.300	15.2	18.5	9.0
After 5 months	0.130	0.485	0.365	16.9	23.5	13.3
After 7 months	0.415	0.685	0.574	17.2	46.9	32.9

The data presented in Table 3 show that the amount of solanine in all potato tubers after 7 months storing does not the exceed the amount permissible for production.

The reducing sugars take part in the process of solanine synthesis [Frydrecka-Mazurczyk, Zgórska 1996b], so the correlation has been determined. At the beginning of storage the correlation is significant weak (Tab. 4). During storage time the influence of amount of reducing sugars on the accumulation of solanine changes.

The weak correlation at 3–4°C temperatures and the mean correletion at 7–8°C and 9–10°C after 7 months storing has been determined. According the

coefficient of determination the influence of reducing sugars on the accumulation of glycoalkaloid at the beginning storage time is 10.2%. The data show that with the longer storage time the stronger is correlation between reducing sugars and amount of solanine – the determination coefficient after 7 months storing decreases from 1.7 to 4.6 times. Results show that the amount of reducing sugars increases together with the amount of solanine (Tab. 4).

Others authors state that the amount of solanine has the influence on chips taste [Frydrecka-Mazurczyk, Zgórska 1996b]. It has been established that at the beginning of storage the correlation dependence on solanine and taste of chips not been determined (results no shown). After 3 months storage the correlation is reverse weak and after 7 months storing, when tubers calm period is over and the physiological process is more intensive, the correlation is reversibly mean at 7–8ºC and 9–10ºC storage temperatures. The influence of solanine on taste of chips is calculated by the determination coefficient. Beginning of storage time the negative influence of solanine on taste of chips is insignificant – 4.7%. According to the data, the longer time at the storing is solanine negative influence on the taste of chips. Depending on storage temperature the determination coefficient increase 5.5–8 times.

Table 5. The quality of chips, produced from the potatoes stored at different temperatures (estimated in points)

Cultivar	Quality of chips in the 5 points scale			
	after harvest	after 7 months		
		3–4ºC	7–8ºC	9–10ºC
Vokė	5.0	4.1	4.5	4.7
Liepa	4.4	1.8	3.7	3.9
Venta	3.1	3.1	3.0	2.9
Vaiva	3.7	3.4	3.3	3.9
$LSD_{0.05}$	0.6	0.9	0.7	0.7

The experiment results show that quality of potato chips depends on genetic properties of raw potato during storage time. The good quality potato chips are made from Vokė tubers after 7 months storage at 3–4ºC temperatures (Tab. 5). The excellent potato chips are made from Vokė tubers stored at 7–8ºC and 9–10ºC temperatures. But the satisfactory and the bad quality potato chips are made from others potato cultivars independently of the storage temperature (Tab. 5).

CONCLUSIONS

1. After 7 months storage the smallest losses of dry matter and starch are determined in Vaiva and the biggest – in Liepa cultivar tubers.

2. The losses of total and reducing sugars, amount of solanine after 7 months storage increase in all potato cultivars.

3. Vokė cultivar potato tubers are suitable for production of good and excellent quality chips, and other cultivars are suitable of this production.

REFERENCES

Frydrecka-Mazurczyk A., Zgórska K. 1996a. Wpływ warunków klimatycznych podczas wegetacji oraz przechowywania na jakość ziemniaków preznaczonych na produkty smażone. [W:] Ziemniak jako surowiec do przetwórstwa spożywczego. Wyd. Inst. Ziemn. Bonin, 44–48.

Frydrecka-Mazurczyk A., Zgórska K. 1996b. Zavartość glikoalkaloidów w bulwach ziemniaka. Ziemniak Polski 4, 10–12.

Frydrecka-Mazurczyk A., Zgórska K. 1999. The influence of maturity, mechanical damages and light exposure on glycoalkaloid content in potato tubers. Abstracts of 14th Triannal Conference of EAPR, Sorrento, Italy, 2–7 May, 651–652.

Lisinska G. 1992. Chłodzone, podsmożone półprodukty ziemniaczane. Wyd. AR we Wrocławiu.

Pęksa A. 1994. Effect of cultural factors and storage conditions on the chemical composition of potatoes and quality of the chips. Zesz. Nauk. AR we Wrocławiu 224, 9–28.

Sowa G. 1988. Udział transpiracji bulw ziemniaka w powstawaniu ubytków naturalnych podczas przechowywania. Ziemniak 3, 61–77.

Sowa-Niedziałkowska G. 1997. Informacja o trwalosci przechowalniczej odmian ziemniaka zrejonizowanych w latach 1965 – 1995.Biul. Inst. Ziemn. 48, 2, 55–56.

Tarakanovas P. 1996. Selekcinių– genetinių tyrimų rezultatų apdorojimo ir Įvertinimo sistema "Selekcija". Dotnuva – Akademija, 30–52.