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THE ECOLOGICAL ASPECTS IN THE POTATO TUBER STORAGE

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Introduction

Sprouting is a major cause of losses in stored potato tubers. Sprouting doses not only reduce the number of marketable potatoes, but intensified evaporation of water from sprout surface, reduces also the weight of remaining tubers. There are two main methods of keeping potatoes sprout free during storage: storing at low temperatures (2 to 4°C) and using the sprout suppressants.

Low temperatures, however, cause the degradation of starch to sugar and increase the tubers sweetness. Many chemical compounds are known to inhibit sprouting [AFEK et al. 2000]. It has been known since 1969 that naturally occurring volatile substances like pulegone and carvone also inhibit the sprouting [OOSTERHAVEN et al. 1993]. Some monoterpens inhibit the sprouting of potato tubers. From these monoterpens S-carvone has promising potential as a commercial sprout inhibitor [OOSTERHAVEN et al. 1993].

Dill and caraway could be interesting crop for production of the potato sprouting inhibitor S-carvone. The essential oil in seeds of the umbelliferes dill and caraway contains about 50% s-carvone [WANDER, BOUWMESTER 1996].

Natural potato sprout inhibitors were already used in the ancient Inc cultures. After harvest, the potato tubers were stored in boxes or bins together with the twigs of muna plants (*Minthostachys* sp.). Treating the tubers in this way controlled sprouting as well as insect attack during prolonged storage.

S-carvone inhibits the sprouting of potato tubers and the sprout growth reversibly: removal of S-carvone allows sprouting and regrowth of individual sprouts. A high dosage leads to necrosis, but the side buds maintain their viability and they start to sprout again when the concentration of S-carvone in the atmosphere comes below a threshold value [OOSTERHAVEN 1995].

The aim of experiment was to estimate reaction of five potato cultivars on natural inhibitors applied during 7 months of storage.

Material and methods

In 2003–2005 the potato tubers of five cultivars (Goda, Gloria, Nida, Vaiva and Voke) were stored at 7 to 8 (± 0.5)°C and 90–95% relative humidity for 7

months in 120μ thick polythene bags over 10 kg in each by four replications.

Natural sprout inhibitors – caraway (cv. Gintaras) and dill (cv. Grybovskij) seeds oils were used. The oils of dill and caraway seeds were made by commonly used steam distillation method (under laboratory conditions).

Potato tubers were treated with the sprout inhibitors four weeks after harvest.

The total and natural weight losses (%), sprouts length and number, the number of buds were rated after 7 months' storage, contents of starch (%) and dry matter (%) were rated after harvest and after 7 months of storage.

Scheme of the experiment:
C – untreated (control);
CSEO – caraway seed essential oil;
DSEO – dill seed essential oil.

The experiment included two factors: cultivar and different sprout inhibitor. The research data were calculated using two-way disperse statistical ANOVA programme [TARAKANOVAS 1999].

Results and discussion

Potatoes, like the other tuber crops, are subjected to postharvest losses owing to their continued metabolism, damages during harvesting and handling, rotting, shriveling, and sprouting. Some loss of weight during storage is inevitable (water loss and respiration). According to average research data (2003–2005) the weight loss during storage increased throughout the time, and there were important differences between control and treated potatoes. For all cultivars both the total weight loss and the losses due to sprouting after seven months storage were higher in control as compared with the treated tubers (Tab. 1, 2). The smallest (5.56%) natural weight losses were observed in all variants for Goda cv. and the highest (8.45%) – for Gloria cv.

Table 1; Tabela 1

Natural losses (%) in potato tubers after 7 months of storage
Ubytki naturalne (%) bulw ziemniaków po 7 miesiącach przechowywania

Cultivar (factor A) Odmiana (czynnik A)	Treatment forms (factor B) Sposób traktowania (czynnik B)			Average of factor A Średnia dla czynnika A $LSD_{0.5}$; $NIR_{0.5}$ = 0.8
	control kontrola	caraway seed essential oil olejki eteryczne nasion kminku	dill seed essential oil olejki eteryczne nasion kopru	
Gloria	9.20	7.88	8.26	8.45
Goda	6.09	5.59	5.00	5.56
Nida	7.25	6.55	6.30	6.70
Vaiva	9.49	7.40	6.34	7.74
Voke	8.07	7.06	6.59	7.24
Average of factor B Średnia dla czynnika B $LSD_{0.5}$; $NIR_{0.5}$ = 0.6	8.02	6.90	6.50	

Table 2; Tabela 2

Number of potato sprouts, buds and length of sprouts (mm) after 7 months of storage
Liczba kiełków i pączków oraz długość kiełków (mm) po przechowywaniu przez 7 miesięcy

Cultivar (factor A) Odmiana (czynnik A)	Treatment forms (factor B) Sposób traktowania (czynnik B)			Average of factor A Średnia dla czynnika A $LSD_{0.5}$; $NIR_{0.5}$ = 0.7
	control kontrola	caraway seed essential oil olejki eteryczne nasion kminku	dill seed essential oil olejki eteryczne nasion kopru	
Sprouts number; Liczba kiełków				
Gloria	4.3	1.2	2.0	2.5
Goda	4.4	3.1	1.5	3.0
Nida	2.7	0.7	0.8	1.4
Vaiva	3.9	2.2	1.8	2.6
Voke	3.0	1.5	0.7	1.7
Average of factor B Średnia dla czynnika B LSD_{05}; $NIR_{0.5}$ = 0.6	3.7	1.7	1.4	
Buds number; Liczba pączków				LSD_{05}; $NIR_{0.5}$= 0.8
Gloria	1.6	1.9	1.3	1.6
Goda	1.6	1.7	2.0	1.8
Nida	2.9	2.2	4.0	3.0
Vaiva	0.9	2.6	2.6	2.0
Voke	2.1	2.3	4.1	2.8
Average of factor B Średnia dla czynnika B $LSD_{0.5}$; $NIR_{0.5}$ = 0.7	1.8	2.1	2.8	
Longest sprouts; długość kiełków (mm)				$LSD_{0.5}$; $NIR_{0.5}$ = 1.8
Gloria	31.4	4.8	5.4	13.9
Goda	31.9	1.9	1.2	11.7
Nida	25.8	2.0	1.9	9.9
Vaiva	68.4	6.9	5.2	26.8
Voke	39.5	2.2	2.0	14.6
Average of factor B Średnia dla czynnika B $LSD_{0.5}$; $NIR_{0.5}$ = 1.7	39.6	3.6	3.1	

During sprouting, starch is enzymatically broken down to simple carbohydrates, like fructose, glucose and sucrose, while the evaporation and weight losses also increase [CALDIZ et al. 2001].

Sprout suppression is normally practised on late – stored potatoes, and the sprout growth is not a major source of losses any more.

The potato tubers at harvest are dormant and will not sprout. As the period of postharvest storage is extended, tuber dormancy is broken and the sprout growth commences [SUTTLE 2003]. S-carvone proved to be effective in sprouting inhibition and its effect was visible. In the case of sprouting, tubers treated without sprout inhibitors after 7 months of storage were characterized by a high

sprout number (average 3.7) as well as by the longest sprouts (39.6 mm), as compared to those treated with sprout inhibitors (1.6 and 3.4 mm respectively), (Tab. 2). The high number of buds after 7 months of storage was observed in potato tubers with natural sprout inhibitors.

During the rest period the level of auxin in tubers is very low. In the spring, when rest was broken, auxin influences the sprout growth in untreated potato tubers. The sprouted potatoes are not suitable for processing and domestic consumption [SUTTLE 2004].

The loss of tuber dormancy and onset of sprout growth are accompanied by numerous biochemical changes, many of which detrimental to nutritional and processing qualities of potatoes [SUTTLE 2003]. The average results of three-year storage showed that the highest amount of dry matter has been accumulated in Goda cv. potato tubers, the smallest – in Vaiva cv. (Tab. 3). Dry matter content of potato tubers decrease from approximately 21.53% in treated potatoes to 20.77% in the control.

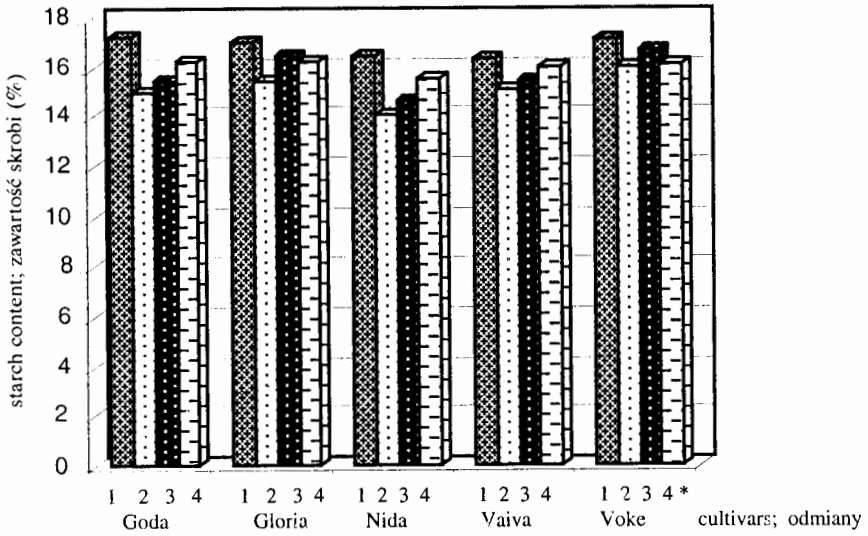
Table 3; Tabela 3

Dry matter content (%) in potato tubers after harvest and 7 months of storage
Zawartość suchej masy (%) w bulwach ziemniaków po zbiorze i przechowywaniu przez 7 miesięcy

Cultivar (factor A) Odmiana (czynnik A)	After harvest Po zbiorze	Treatment forms (factor B) Sposób traktowania (czynnik B)			Average of factor A Średnia dla czynnika A $LSD_{0.5}$; $NIR_{0.5}$ = 0.5
		control kontrola	caraway seed essential oil olejki eteryczne nasion kminku	dill seed essential oil olejki eteryczne nasion kopru	
Gloria	22.73	21.17	22.15	21.53	21.90
Goda	23.02	21.67	22.05	22.23	22.24
Nida	22.19	20.22	20.87	20.86	21.04
Vaiva	22.14	19.92	21.24	21.72	21.26
Voke	22.89	20.88	21.28	21.35	21.60
Average of factor B Średnia dla czynnika B LSD_{05}; $NIR_{0.5}$ = 0.3		20.77	21.52	21.54	

The starch content in potatoes decreased during storage. The highest loss of starch after 7 month storage was found in untreated potato tubers (Fig. 1). Significantly highest positive effect was obtained in potato tubers treated with caraway seed essential oil, except of Voke and Vaiva cvs. The amount of starch was depended on the cultivars. The significantly smallest amounts of starch after harvest and at the end of storage were in Nida and Vaiva cvs.

Loss of starch is of obvious importance in the potatoes used for starch production, but it can also influence the quality of culinary potatoes. Starch is an ultimate source of respiratory substrates, hence of the C lost with CO_2 during respiration.



* 1 after harvest; po zbiorze 2 untreated (control); kontrola
3 caraway seed essential oil; olejki eteryczne nasion kminku
4 dill seed essential oil; olejki eteryczne nasion kopru

Fig. 1. Starch content (%) in potato tubers
Rys. 1. Zawartość skrobi (%) w bulwach ziemniaków

Conclusions

Dill and caraway seed oil treatments delayed initial sprouting date and inhibited sprout growth during storage period up to seven months, what resulted in lower weight loss due to sprouting. Moreover, the natural growth inhibitor treatments after seven month storage fractionally reduced the dry matter and starch content in potato tubers.

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Key words: potato, carway seed essential oil, dill seed essential oil, sprout inhibition

Summary

Over 2003 to 2005 in Lithuanian Agricultural University the laboratory research was carried out concerning the effect of caraway seed and dill seeds essentials oils on the storage of five potato cultivars.

Research results showed that after 7 months of storage the smallest natural mass losses occured in potatoes of Goda cultivars, which were treated by plant inhibitors.

The smallest mass of sprouts was observed in Nida cultivars treated by plant inhibitors.

WPŁYW NATURALNYCH INHIBITORÓW WZROSTU NA JAKOŚĆ ZIEMNIAKÓW W OKRESIE PRZECHOWYWANIA

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Słowa kluczowe: ziemniak, olejki eteryczne nasion kminku, olejki eteryczne nasion kopru, inhibitory kiełkowania

Streszczenie

Materiałem do badań były próby ziemniaków odmian – Voke, Vaiva, Nida, Goda, Gloria pochodzących z sezonów wegetacyjnych 2003–2005. Jako środek hamujący kiełkowanie podczas przechowywania ziemniaków w temp. 7–8°C wykorzystano naturalne inhibitory w postaci olejku eterycznego wyekstrahowanego z nasion kminku odmiany Gintaras i nasion kopru odmiany Gribowskij.

Po 7 miesiącach przechowywania określono: ubytki naturalne bulw (%), ilość i długość kiełków oraz zawartość suchej masy i skrobi w bulwach.

Stwierdzono, że wykorzystanie olejków z nasion kminku i kopru jako środ-

ków hamujących kiełkowanie ziemniaków wpływa na zmniejszenie ubytków naturalnych bulw, zmniejsza straty skrobi i suchej masy. Wielkość tych zmian zależała od odmiany ziemniaka. Najmniejsze ubytki naturalne bulw po 7 miesięcznym przechowywaniu odnotowano w bulwach odmiany Goda traktowanych inhibitorami kiełkowania.

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