

Influence of potato growth and storage conditions on the quality of fresh table potato and potato products in the central part of Russia

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Abstract

Twelve potato cultivars with different maturing times (early (Zhukovskiy ranniy, Skoroplodniy, Udacha), mid-early (Belosnezhka, Iliyanskiy, Nevskiy, Effect, Bronnickiy, Golubizna), and middle-late (Belousovskiy, Malinovka, Osen)), recommended for central Russia, have been selected by Potato Research Institute and North-Western Agriculture Research Institute and tested for their yield, quality and suitability for processing (production of potato chips and dried potato mash). The cultivars tested differ in the reaction for reconditioning and blanching. The treatment with Maxim, Kolfugo super, Vist (fumigant), and Sprout Stop preparations provided an improvement of the keeping quality, future yield, and decrease of the reducing sugars content. For the central Russia, characterizing by sod-podzol soils, the following potato cultivars were the most suitable for processing: Belosnezhka, Bronnickiy, Golubizna, Effect (for light clay soil), and Belosnezhka, Golubizna, Nevskiy, Effect (for moderate loam soil). Tubers, intended for the chip production, should be stored at 6-8°C and treated with Sprout-stop in January-February. Tubers, intended for the dried potato mash production, should be grown on the moderate loam soil and stored at 2-4°C.

Keywords: potato storage, potato processing, reducing sugars content, potato cultivars for processing

Introduction

In recent years a tendency towards an increase of the significance of potato processing into different products is observed in Russia. It is known that the yield, quality, and suitability for processing of potato cultivars depend on the growth conditions, soil type, and storage temperature and duration. In the present paper we are trying to estimate the prospects of cultivating of twelve recommended for central Russia potato cultivars, having different maturing time, for their use in processing industry.

Materials and methods

The experiments were carried out in 2000-2006 in the Moscow region and involved two soil types: moderate loam (loam) and light clay (clay) soils. The loam has the higher humus (2,4-2,5%) and phosphorus (182-231 mg/kg) content in comparison with the clay. The actual acid content (Ph(KCl)) was 4,45-5,25. A standard cultivation technology, recommended for the central region, was used. For the loam and the clay we used the active and passive soil cultivation, respectively. Potato tubers were stored in refrigerators at 2-4°C and 6-8°C (RH 85-95%), and also in potato storage facilities with active ventilation. The laboratory and field tests were performed according Dospekhov (1983) and Dospekhov (1985), respectively. The comparison of different methods (based on the test-paper application) for the determination of

a reducing sugars content in tubers was done. Bertrane's method was used as a control one. The best results were obtained for the use of a glukourichrom test-paper, so we decided to use this kind of the test-paper in our experiments.

The influence of different biological and chemical preparations (Maxim, Kolfugo super, Vist (fumigant), and Spraut Stop) on the potato storage and product quality was studied. The taste of table potato and potato products was appreciated using a 9-point scale.

Twelve potato cultivars, recommended for central Russia and having different maturing time (early (Zhukovskiy ranniy, Skoroplodniy, Udacha), mid-early (Belosnezhka, Ilyinskiy, Nevskiy, Effect, Bronnickiy, Golubizna), and middle late (Belousovskiy, Malinovka, Osen)) were selected by Potato Research Institute and North-Western Agriculture Research Institute and tested during our study.

Results and discussion

Production of potato cultivars

Environmental conditions provide the most important influence on the production, structure, and quality of the crop. Comparing to the clay, the yield of all cultivars on the loam was higher (+0,9-4,6 t/ha). In dry years the yield on the loam was 2-3 times higher, than on the clay. These facts correspond to the results, obtained by Lorch (1948), who wrote that on the clay soil plants require more water, than on the loam soil, and Kiryukhin (1970), who wrote that in the case of dry July-August the tuber formation is depressed.

All cultivars, except Belousovskiy, Ilyinskiy, and Malinovka, formed many stems on the clay. The maximum number of stems was registered for cv. Belosnezhka: 7,0 stem/plant on the clay and 6,2 stem/plant on the loam. The maximum height of plants in the budding phase was registered on the loam. Cvs. Belousovskiy, Malinovka, and Skoroplodniy grew well on both soil types.

The yield structure is very important for the tuber processing. The fraction of tubers, diameter of which was 40-80 mm, was higher for the loam soil. For cvs. Belosnezhka, Bronnickiy, Golubizna, Ilyinskiy, Malinovka, Osen, and Udacha the most of tubers had the diameter 40-60 mm (optimal for the chip production) if they were grown on the clay.

All tubers, which diameter exceeds 40 mm, can be used in the dried potato mash production. The maximum production of such tubers was observed on the loam.

Storage temperature

The storage temperature greatly influences on the degree of the mass losses, reducing sugars content, quality of chips, and the amount of waste after the abrasive peeling of tubers. This factor has no effect on the quality of the dried potato mash.

For all cultivars the storage at 6-8°C increased the total mass losses in 3-4 times, comparing to the storage at 2-4°C. The storage at 6-8°C provided a good quality of chips without any tuber reconditioning or blanching. The breathing of tubers is the main reason of mass losses at all temperatures. The differences in the mass losses between different cultivars were higher at 2-4°C. The total mass decrease at 2-4°C did not depend on the soil type, but at 6-8°C it was lower, if the cultivars (Belosnezhka, Golubizna, Ilyinskiy, Malinovka, Skoroplodniy, Udacha) were grown on the loam.

Biochemical parameters

In our study we determined two biochemical parameters: the solids content and the reducing sugar content. The solids content did not depend on the storage temperature or the soil type.

The reducing sugar content, measured right after harvesting, met the standard requirements (0,15-0,31%) for all cultivars, except for cv. Belousovskiy. During the storage the reducing sugar content increased; the increase rate was maximal at 2-4°C, and minimal at 6-8°C (Fig.1). The increase rate did not depend on the soil type.

Suitability for the chip production

The amount of waste depends on the level of a tuber peeling. In the case of the full peeling (100%), the amount of waste was 20-30% (depending on the cultivar); if the level of peeling was 60-85% (such peeling is still suitable for the chip production), then the amount of waste was 10-15%. Different storage temperatures also affected on this parameter: it varied from 4,4–17% (2–4°C) to 8,3–27,3% (6–8°C).

After-harvest processing of all cultivars grown on both loam and clay soils allowed the production of chips of good quality (>6 points). The best cultivars were Belosnezhka (7,3-7,7 points), Bronnickiy (8-8,7), Golubizna (6,3-7,3), Nevskiy (7,3-8,0), Effect (8-8,3). During the storage at 2–4°C, the reduced sugar content increased from 0,19-0,32% to 0,27-1,46% in different cultivars. This fact affected the quality of chips, decreasing it by 1-2 points (chips became brown).

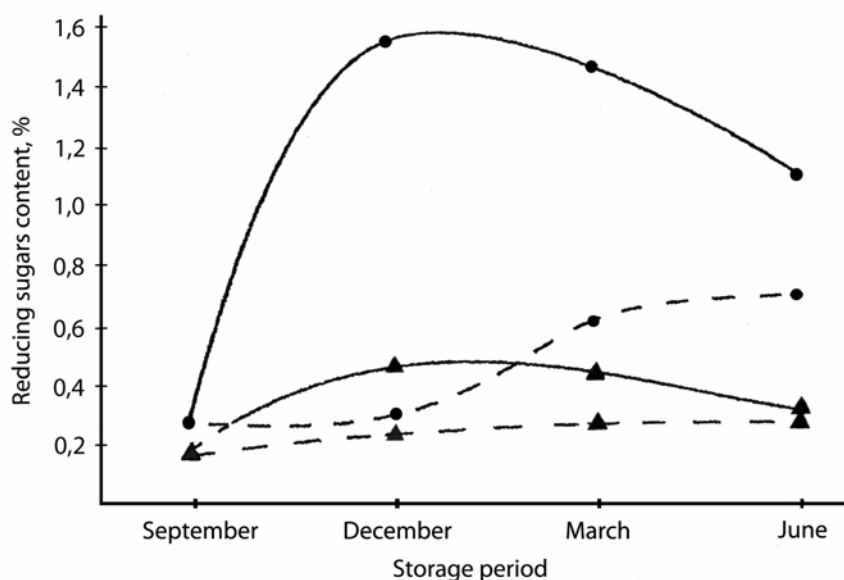


Figure 1. Changes in the content of reducing sugar during the storage of tubers (cvs. Skoroplodniy (●) and Bronnickiy(▲), grown on the moderate loam).

————— storage temperature 3- 4°C
 ----- storage temperature 6- 8°C

The best chips were produced from cvs. Bronnickiy, Golubizna, and Effect, stored at 6-8°C and grown on both soil types, and cv. Nevskiy, grown on the loam. This storage temperature initiated early germination of tubers and decreased their turgor. In this connection, the special study of the treatment of tubers with the Sprout–Stop (chlorprofam) germination inhibitor were carried out.

Dried potato mash production

All examined potato cultivars were processed into the dried potato mash of good or excellent quality (>6 points). A small decrease in the product quality was observed in the case of the

spring processing of tubers, stored at 2-4°C. Tubers of cv. The taste of tubers of cv. Udacha (cultivated on the clay) decreased during a storage period from 7,4 (autumn processing) to 5,6 points in spring. The spring processing of cvs. Belosnezhka, Belousovskiy, Golubizna, Malinovka, Osen, and Effect, grown on the loam, provided the better taste (7,4-8,4 points) in comparison with those, grown on the clay (5,6-7,2 points).

Resistance to the tuber pulp darkening

Cvs. Belousovskiy, Bronnickiy, Malinovka, Nevskiy, and Golubizna were the most resistant to the tuber pulp darkening independently of the cultivation or storage conditions. A small decrease in the resistance was registered at the end of the storage period for the tubers, cultivated on the loam. Fresh peeled tubers of all tested cultivars were not suitable for the storage for more than 24 hours because of their darkening.

The resistance of boiled tubers of all tested cultivars (except Belosnezhka and Effect) to the darkening was quite good independently of any cultivation or storage conditions. Peeled boiled tubers did not decrease their quality after 24-hour storage. Tubers, grown on the loam, showed better results. Boiled tubers of cvs. Belosnezhka, Bronnickiy, Golubizna, Zhukovskiy ranniy, Ilyinskiy, Malinovka, Osen, and Effect demonstrated moderate or good taste.

Chip quality improvement

Reconditioning is one of widely used methods to decrease the content of reducing sugars. In our study this method included the storage of tubers at 20-22°C for 20-22 days. The application of such procedure provided an increase in the quality of chips, manufactured from cvs. Belosnezhka, Bronnickiy, Golubizna, Nevskiy, and Effect, cultivated on both soils, Malinovka and Osen, cultivated on the loam, and Udacha, cultivated on the clay.

Blanching is another method to decrease the content of reducing sugars, including the blanching of tuber's slices (1,2 mm thick) with the hot water (80-95°C) for 2 minutes with the following washing with water. The duration of the subsequent frying should not exceed 4 minutes. The blanching increased the quality of chips, manufactured from tubers of the most of tested cultivars, which have been stored at 2-4°C for a long time. The blanching was not necessary for the most of cultivars in the case of the after-harvest tuber processing. In this case it can decrease the quality of chips, because they can become gray. The blanching was ineffective in the case of processing of potato, grown in 2002 (dry and hot year).

Therefore, the blanching machine should be included into the processing line as an optional equipment to be used as necessary.

Chemical and biological treatment of tubers

Influence of protecting and stimulating preparations on tubers during the storage period was also studied. Cvs. Nevskiy and Udacha were selected for such study. The autumn treatment of tubers increased their keeping quality. The best results were shown for Maxim and Kolfugo-super preparations (0,2 l/ton). They decreased the mass losses in 2-2,3 times. Total yield of the next season increased by 3,7-5,2 t/ha. The fumigation of potato with Vist (tiabendazole) in the dose 10g/t gave an additional yield +3,7-5,1 t/ha. The treatment with Sprout-stop (dust) in the dose 1,0 kg/t decreased mass losses up to 20% (in comparison with the non-treated control), increased the next season yield by 2,4-5,1 t/ha, decreased the content of reducing sugars, and increased the quality of chips on 2-3 points for all tested cultivars, excepting Zhukovskiy ranniy, Scoroplodniy, and Ilyinskiy.

Conclusions

For the Central Russia (sod-podzol soils) we can recommend to grow the following potato cultivars for the further processing: Belosnezhka, Bronnickiy, Golubizna, Effect - for light clay soils, and Belosnezhka, Golubizna, Nevskiy, Effect - for moderate loam soils.

Tubers, intended for the chip production, should be stored at 6-8°C and treated with Sprout-stop in January-February. Tubers, intended for the dried potato mash production, should be grown on the moderate loam soil and stored at 2-4°C.

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