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INFLUENCE OF THE FIELD STORAGE ON THE CONTENT OF BASIC MOLASSES IN ROOTS OF VARIOUS SUGAR BEET HYBRIDS

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Abstract

An important criterion in assessing varieties and hybrids of sugar beet is their ability to long-term storage. Therefore, the selection of sugar beet hybrids, which have good keeping quality, is becoming one of the pressing issues of the sugar beet industry. Changes in the quality indicators of root mass during storage were monitored after 30 and 60 days according to the generally accepted method, which provides for laying mesh samples. As a result, it was found that in the root mass of hybrids of normal type the content of α-amino nitrogen increased after 60 days of storage by 2.5-2.9 times compared with the initial state, hybrids of normal yielding type - by 2.7-3.0 times , normal sugar type - 3.3 times, and sugar type - more than 4 times. The accumulation of sodium in root mass in all hybrids occurred approximately equally. For three years of research, after 60 days of storage, the most sodium was found in root mass of the normal compact and Hercules hybrids, and least of all - in the root mass of sugar type.

Key words: *α-amino nitrogen, potassium, sodium, field storage, sugar beet.*

INTRODUCTION

The solution to the problem of obtaining high and stable sugar beet crops with good technological properties of root mass is often limited to the use of foreign varieties and hybrids that are not adapted to local conditions. Recently, many sugar beet producers have switched to using other seed material for sowing, guided mainly by its high yield, not taking into account the yield of the main product - sugar after storage and processing (Loel et al., 2014).

In recent years, in the Russian Federation there has been a significant increase in the production of sugar beet and the volume of its preparation by sugar factories. In these conditions, the preservation of the grown crop and timely processing become one of the urgent issues of the beet-growing industry. During the mass-harvesting of beets, sugar plants accumulate a large amount of raw materials, which cannot be processed immediately. Since sugar factories cannot immediately accept the entire harvest, the root crops are stored for storage in kagats (Kostin et al., 2017; Stevanato et al., 2019). In the first 5-10 days after harvesting, a significant part of the sugar loss occurs (daily 0.15%). During this time, approximately the same amount of sugar is lost as in the following 60-70 days of storage in the unloading units (Bobrivnyk et al., 2016).

An important criterion in assessing varieties and hybrids of sugar beet is the ability of root mass to long-term storage (Monteiro et al., 2018). The traditional method of storing sugar beet root mass before processing at sugar factories is to put them in kagats (Dolgopolova, 2011). This is not the best way, but in the soil and climatic conditions of Russia it justifies itself. With such storage, losses occur for unavoidable reasons associated with biochemical respiration reactions and for dependent reasons caused by the phytosanitary state of root mass and weather conditions.

MATERIALS AND METHODS

The studies were conducted in the conditions of the local company "Krasnaya Gorka" in the Kolyshleysky district of the Penza region (Russia). Sugar beet hybrids were studied in the experiment: 1 - F_1 PMC 120; 2 - F_1 Compact; 3 - F1 Hercules; 4 - F1 Spartak; 5 - F_1 XM 1820; 6 - F_1 Nero; 7 - F_1 Triad; 8 - F_1 Badia; 9 - F_1 Volga. Soil - medium-loamy leached chernozem, whose arable layer was characterized by the following agrochemical parameters: humus content of 5.64%, mobile forms of nitrogen 103 mg/kg, phosphorus and potassium - 94 and 100 mg/kg, respectively; pHKCl - 5.5, Ng - 4.8 mEq/100 g, S - 29.8 mEq/100 g of soil. For storage, a site was selected at the edge of the field.

The reclaimed earth area before laying the beets was leveled, watered and treated with cannon-lime (0.2 kg/m^2). Root mass laid for storage was assigned to category II, designed for medium storage periods (up to 2 months). Kagati without shelter were formed during the harvesting period, placed near a dirt road with orientation from north to south.

Kagat sizes: 3-4 m high and base width 12–16 m. Changes in the quality indicators of root mass were monitored after 30 and 60 days of storage in accordance with the generally accepted method that provides for the laying of mesh samples. For this, samples were formed that were homogeneous in mass, phytopathological state, and quality. The mass of each of them is 12 kg. Samples were weighed, labeled, analyzed in order to determine the initial quantitative and qualitative indicators of the beetroot being driven and placed in storage in the appropriate section of the beetroot to a depth from the upper part of 1.0-1.5 m. The quality indicators were determined in 30 and 60 days. After the expiration of the storage period, the nets were removed from the cages and the same indicators were determined as in the bookmark: the sucrose content was measured using an AP-05 polarimetric sugarmeter, potassium and sodium using a potentiometric method, and α-amine nitrogen was photometric method. The experiment was carried out in triplicate.

RESULTS AND DISCUSSIONS

After harvesting, sugar beet roots are a qualitatively different biological organism compared to vegetation. During storage, hydrolytic decay processes predominate and natural changes in the composition of sugar beet occur. All this leads to a deterioration in the technological qualities of sugar beets, a decrease in the sucrose content and the accumulation of non-sugars. When storing intact root mass under optimal conditions, with a correctly trimmed head, sucrose is consumed primarily for respiration and the magnitude of these losses is negligible. But during storage of damaged root mass containing a large amount of green mass, earth and other impurities, breathing processes are enhanced and sucrose losses increase dramatically.

It is known that during storage in root mass complex physiological, biochemical, microbiological and other processes occur that lead to the loss of sucrose, to the accumulation of nob-sugar - mainly potassium, sodium and alpha-amine nitrogen, which interfere with traction of crystallized sugar remaining in molasses.

Researchers have found that after 30 days of storage, the sugar content of root mass decreased by 0.32-1.02%. The smallest sugar loss during storage - 0.32% - was observed in the F1 Triad hybrid, and the largest sugar loss was observed in the F_1 Spartak hybrid (1.02%). In hybrids of the normal type, the loss of sugar content was 0.35-1.02%, of the normal-crop type - 0.93-0.94%, of the normal-sugar type - 0.32-0.36%, of the sugar-type type - 0.69%.

After 30 days of storage in the root crops of all the studied hybrids, an increase in the content of the main molas co-formers: K, Na, and α-amino nitrogen was observed. The potassium content increased by 0.016-0.038%, sodium - by 0.003-0.049%, depending on the hybrids. The maximum amount of sodium was accumulated in the root crops of the F1 Compact hybrid - 1.44 mmol/100 g, the minimum - of the sugar Volga F1 hybrid - 0.78 mmol/100 g.

The increase in the content of α-amino nitrogen was from 0.015% to 0.023% by weight of the root mass, and the maximum content of this molass former was in the hybrid of the normal type F1 PMC 120 and amounted to 3.43 mmol/100 g sugar beets (Figure 1).

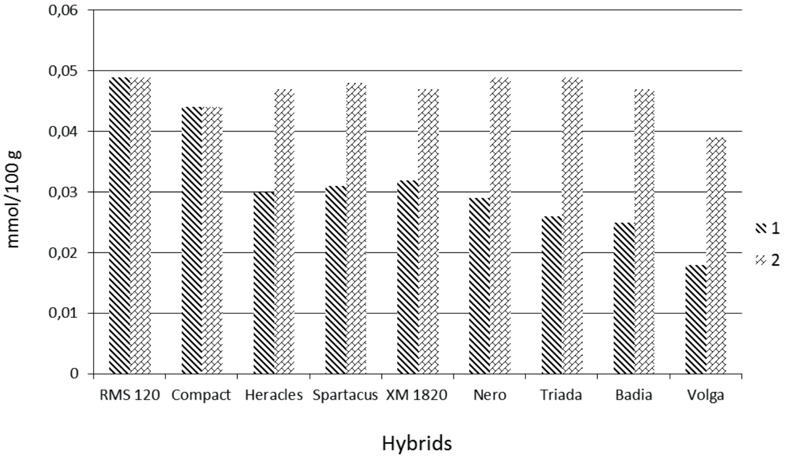

Figure 1. The content of α-amino nitrogen in the roots of sugar beets: 1 - before laying it for storage; 2 - 30 days after storage

It was found that during storage of the fluctuation of air temperature with a change from negative to positive, they significantly influenced the content of harmful nitrogen, since when thawing root mass, most of the sucrose turns into invert sugar, the amount of harmful nitrogen increases, the sugar yield decreases and the molasses yield.

After 60 days of storage, a tendency toward gradual stabilization of the technological parameters of sugar beet root mass was noted.

On average, over the years of observation after 60 days of storage, the following changes in the technological qualities of root fruits were noted. The potassium content in the root crops of the normal type increased by 17.2-26.9%, except for the F_1 Spartak hybrid, in which the content of this molass former increased by 9.5%. In the root mass of hybrids of the normally productive type, the amount of potassium was 1.03 mmol/100 g (F1 Nero) and 0.897 mmol/100 g (F_1 XM 1820). Of all the studied hybrids, the minimum increase in the content of potassium during the storage period was observed in root-sugar-type root mass: in the Triad hybrid, the increase was 17%, in the F_1 Badia hybrid - 15.8%. After storage in the roots of the Volga hybrid F_1 (sugar type), the amount of potassium was 4.127 mmol/100 g, i.e. an increase of 27.8%.

During storage, there was an increase not only in potassium, but also in sodium. On average, over four years, after 60 days of storage, the most sodium was found in root mass of normal hybrids F_1 Compact (1.590 mmol/100 g) and F_1 Heracles (1.580 mmol/100 g), and least of all in root mass of hybrids yes F_1 Volga (sugar type) - 1.023 mmol/100 g. The amount of α-amino nitrogen after storage in all hybrids ranged from 5.880 to 6.057 mmol/100 g, except for the F_1 Volga hybrid - in the roots of this hybrid it was found 5.323 mmol/100 g. Changes in the content of the main molasses co-formers in root mass after the entire storage period had a direct the influence on standard sugar losses during molasses formation. The results of the studies showed that in the initial storage period (up to 30 days), the main losses of sugar occur, gradually decreasing in the subsequent period. After root crops of F_1 RMS 120 hybrid, after storage for 60 days, the standard sugar loss, which is calculated based on the content of potassium, sodium and “harmful” nitrogen, was 2.78% (Table 1).

Hybrids F_1 Compact and F_1 Hercules (normal type) losses were 2.66 and 2.70%.

In hybrids of the normally productive type (F_1 XM 1820 and F_1 Nero) sugar losses were at the level of the domestic hybrid F_1 PMC 120, in normal-sugar hybrids (F_1 Triad and F_1 Badia) they were 0.17 and 0.21% less than the F_1 PMC 120 hybrid. The sugar-type hybrid has a loss of sugar of 2.38%.

Table 1. Standard sugar loss by sugar beet during the formation of molasses, %

Hybrid F_1 Between	During harvesting	After 60 days of storage
Normal type		
PMC 120	1.79	2.78
Compact	1.61	2.66
Hercules	1,62	2.70
Spartacus	1.75	2.79
Normal yielding type		
XM 1820	1.72	2.77
Nero	1.69	2.77
Normal sugar type		
Triad	1.44	2.61
Badia	1.43	2.57
Sugar type		
Volga	1.22	2.38

One of the indicators of the quality of root mass is the content of purified sugar. The research results showed that hybrids of normal and normal-yield type in terms of sugar storage loss were approximately equivalent, while normal-sugar and sugar type had a positive tendency to reduce sugar loss. For 60 days of storage, on average, for three years of research, the advantage in the content of refined sugar is 15.25-15.80% for hybrids of the normal-sugar and sugar type.

Thus, as a result of the studies, it was found that hybrids of foreign selection related to normal-sugar and sugar types lose more refined sugar during storage than hybrids of normal and normal-yielding types. At the same time, the loss of refined sugar in the F_1 Triad hybrid was 1.11%, F_1 Badia - 1.27% and the F_1 Volga hybrid - 1.28%.

According to the total assessment, which includes the loss of mass of root mass and the amount of molasses forming substances and the final indicator of root crop processing - the yield of refined sugar from 1 ton of root fruits after 30 and 60 days of storage, hybrids of normal-sugar F_1 Triad, F_1 Badia and sugar type are distinguished F_1 Volga.

Hybrids F_1 PMC 120 and F_1 Compact, whose root mass is less adapted to storage conditions in the first 30 days of storage, are better stored in the next 30 days, and hybrids of normal-crop type - on the contrary - losses increase (Table 2 and Table 3).

The effectiveness of using hybrids of different breeding in sugar processing depends on the genetic characteristics and storage conditions.

Table 2. Adaptation features of hybrids when stored in the sacks within 30 days, score

Hybrid F_1	Mass loss	Quantity			Total score	The yield of refined sugar from 1 ton of root mass
		K	Na	α- amino nitrogen		
30 days						
Normal type						
PMC 120	93.4	115.7	104.3	105.3	419	96.6
Compact	97.4	103.2	123.1	95.1	419	97.7
Hercules	102.9	98.5	121.9	101.2	425	99.6
Spartacus	106.6	112.8	119.4	103.2	442	97.5
Normal yielding type						
XM 1820	100.1	112.6	92.9	100.9	407	98.2
Nero	104.6	112.4	105.4	104.3	427	98.0
Normal sugar type						
Triada	97.4	83.6	81.2	105,2	367	102.3
Badia	99.6	83.5	81.5	101.3	366	102.8
Sugar type						
Volga	98.5	77.8	66.7	83.6	327	105.7
Average	100.0	100.0	100.0	100.0	400.0	100.0

Table 3. Adaptation features of hybrids when stored in the sacks within 60 days, score

Hybrid F_1	Mass loss	Quantity			Total score	The yield of refined sugar from 1 ton of root mass
		K	Na	α- amino nitrogen		
60 days						
Normal type						
PMC 120	93.5	115.3	99.7	101.4	410	97.3
Compact	96.3	103.2	119.5	95.3	414	98.0
Hercules	102.0	98.5	118.8	100.6	420	99.5
Spartacus	103.2	112.6	117.8	100.9	435	97.3
Normal yielding type						
XM 1820	102.9	112.6	91.7	102.5	410	97.7
Nero	102.7	111.9	104.0	101.6	420	97.6
Normal sugar type						
Triada	99.8	84.2	85.2	104.4	374	101.8
Badia	99.7	84.6	89.0	100.9	374	102.3
Sugar type						
Volga	99.4	77,7	76,9	91,8	346	105,7
Average	100.0	100.0	100.0	100.0	400.0	100.0

The hybrids F_1 Triad, F_1 Badia and F_1 Volga are the most adapted to storage conditions in field piles and able to give the greatest yield of purified sugar from 1 ton of root mass after 60 days of storage.

CONCLUSIONS

Thus, the studies showed that in the roots of hybrids of normal type, the content of α-amino nitrogen increased after 60 days of storage by 2.5-2.9 times compared with the initial state, hybrids of the normal crop direction - by 2.7-3.0 times, normal-sugar direction - 3.3 times and sugar-more than 4 times. Studies have established that the content of "harmful" nitrogen increases sharply during storage, especially after 30 days of storage. Of all the studied hybrids, the minimum increase in potassium content over 60 days of storage was noted in normal-sugar-type root mass - 0.617-0.683 mmol/100 g. The accumulation in the root crops of sodium in all hybrids occurred approximately equally and amounted to 0.006 - 0.014% by weight depending on the hybrid. The root mass of the F_1 hybrid PMC 120 was more resistant to environmental factors, having an adverse effect on the technological performance of sugar beets. The loss of refined sugar during storage in this hybrid was only 0.91%, which is 1.2-1.4 times less than in other hybrids.

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