# TEMPERATURE AND TIME OF STORAGE IMPACT ON REDUCING SUGAR ACUMULATIONS IN SUGAR BEET

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**Abstract:** *The quality of sugar beet determines its sugar output. Besides its initial quality and harvesting conditions, it is the storage conditions that influence significantly the technological quality of sugar beet. An important indicator regarding the quality of sugar beet is the content in reducing sugars. Throughout the production process, the reducing sugars are some of the forming sources of coloring substances in juices and syrups. The aim of this paper is to determine the effect of storage temperature and time upon the content variation in reducing sugars of the new beet- hybrids adapted to the new climate conditions of Europe, by analyzing statistically the correlations between storage time and temperature on the one hand, and the content variation in reducing substances on the other hand. The sugar beet was stored at different ranges of temperature of 2, 6, 10, 15 and 20 °C and determinations on the content in reducing sugars after 5, 10, 20, 30, 40, 50 and 60 day- storage time were made. The method ICUMSA GS 2/9-6 2007 was used to determine the content in reducing sugars. The data obtained were statistically processed using the program Excel of Microsoft Office XP in order to get the values of correlation coefficients (r) between the content in reducing sugars and storage time depending on storage temperature. The analysis results show that there is a non-uniform variation in time of the content in reducing sugars throughout storage, with significant influence due to the heat level – storage of sugar beet.*

**Keywords:** *sugar beet, storage, temperature, reducing sugars.*

## 1. Introduction

To obtain sugar from sugar beet is economically more advantageous than from sugar-cane as sugar beet contains by 25 % more sugar than cane [1].During storage, the chemical composition of beets changes and the amount of the recoverable sugar thus declines. Sucrolitic enzymes cleave sucrose to glucose and fructose. These hexoses mainly fuel beet respirations, but a certain amount accumulates in cells [2]. Besides temperature, the storage time has an important influence upon the technological quality of the sugar beet stored [3]. This one is influenced both by the sucrose content and percentage of substances preventing sugar from getting crystallized during the refining process [4]. The production of inverted sugar after harvesting is the result of sucrose hydrolysis and metabolic processes of respiration in beet roots [5]. In the first hours of storage, the quantity of inverted sugar decreases as a result of the decrease of invertase activity and consumption of the reducing sugars in metabolic processes occurring in sugar beet roots [6]. Therefore, the quantity of inverted sugar increases constantly by a rate depending both on storage conditions and health state of beet. Sugar beet cultivars differ among

them both in their quantity of sugar accumulated during the vegetation period and storage behavior [7]. The quantity of inverted sugar in beet is considered an indicator of its technological quality on the one hand due to the fact that the inverted sugar is obtained from sucrose degradation and on the other one some organic acids of undesirable effect are getting formed from inverted sugar processing.
The new climate conditions of Europe have imposed the cultivation of some new hybrids of sugar beet adapted to these ones. Knowing the behaviour of these hybrids during storage and how high quality of sugar beet can be obtained after its storage is very intersting for sugar technology, because the quality of raw material affects all technological process for obtaining sugar. In the present study the behaviour of sugar beet has been studied for 60 days and this is usually the maximum storage period of sugar beet after harvest until processing.

## 2. Experimental

The beet to be analyzed represents Victor hybrids of type Z, Soleia of type N/Z and Markus of type Z cultivated in the county of Brasov. The sugar beet has been stored together with its adherent impurities at the temperature ranges of 2, 6, 10, 15 and 20 $^{o}$C and determinations on the sucrose content after storage periods of 5, 10, 20, 30, 40, 50 and 60 days have been made. The results obtained were used to determine the accumulating rate of reducing sugars in sugar beet depending on the storage temperature used. The determination of reducing sugars content was made using GS 2/9-6 2007 [8]. The information obtained was statistically processed using software Excel in Microsoft Office 2003 Suite in order to find values of correlation coefficients (r) [9] between storage time and temperature and variations of sucrose content of the sugar beet analyzed.

## 3. Results and Discussion

The experimental results obtained after the samples of cultivar Victor of type Z have been stored at different levels of temperature which can be seen in figure 1.

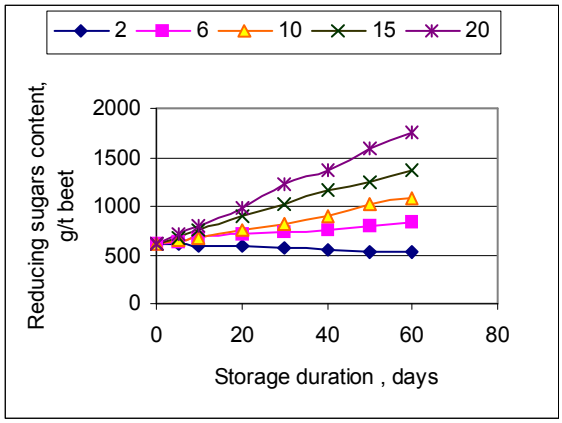


**Figure 1: Reducing sugar content of cultivar Victor stored at different temperatures**

As regards the storage behavior of cultivar Victor, when the heat level of 2$^{o}$C is used, there is a slight decrease in the reducing sugars content displaying a limiting tendency towards the end of the storage period.
When the storage temperature is scaled up to 6$^{o}$C, there is a continuous increase of the parameter analyzed. At temperatures of 10, 15 and 20 $^{o}$C there is a more and more significant increase of the reducing sugars content with small variations specific to each heat level. The average value of the accumulating rate of reducing sugars depending on temperature was calculated and the results are shown in figure 2.

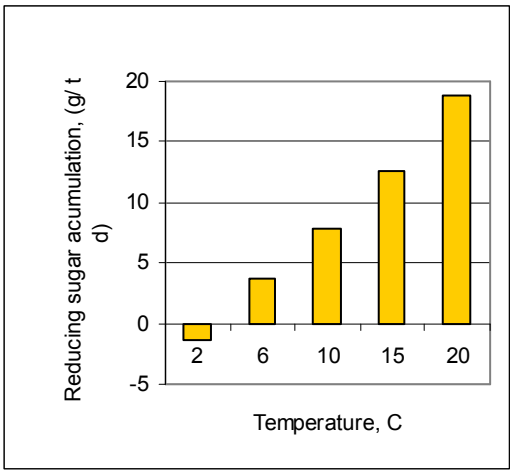


**Figure 2: Rate of invert sugar accumulation depending on temperature during storage (cultivar Victor).**

After having analyzed the accumulation rate of reducing sugars in the case of cultivar Victor, we can notice that the maximum value of the accumulation rate in degree is reached during the heat temperature range 2-6 $^{o}$C whereas the minimum one in the range 6-10 $^{o}$C. For the temperature 10-15 $^{o}$C and 15-20 $^{o}$C, slightly lower values were registered than the maximum one.

The cultivar Soleia had the following storage behavior that can be seen in Figure 3.

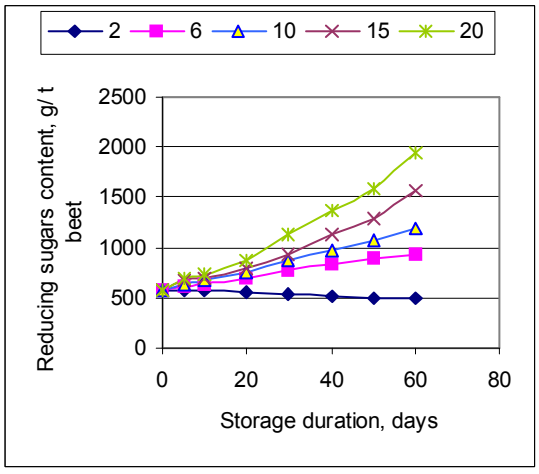


**Figure 3: Reducing sugar content of cultivar Soleia stored at different temperatures**

As a peculiarity of the cultivar Soleia, this one had a similar behavior to the storage heat ranges of 6 and10$^{o}$C. Thus, the same as in the case of the cultivar Victor, there is a decrease in the reducing sugars content after a storage period at 2$^{o}$C.

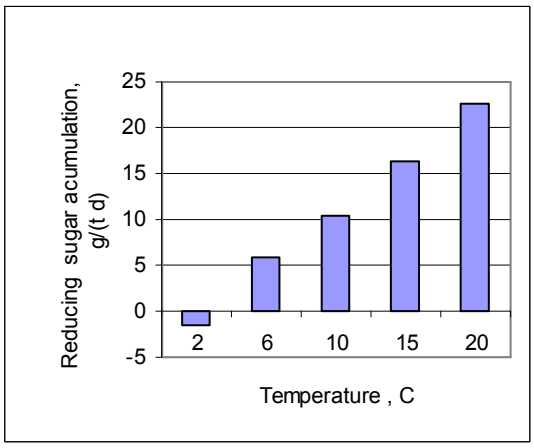


**Figure 4: Rate of invert sugar accumulation depending temperature during storage (cultivar Soleia)**

The accumulation rate of reducing sugars in the case of the cultivar Soleia reaches the maximum of increase in the temperature range 2-6 $^{o}$C, the rest of ranges having relatively close values to the parameter analyzed.

The evolution of reducing sugars content of the cultivar Markus' storage duration led to the results shown in figure 5.

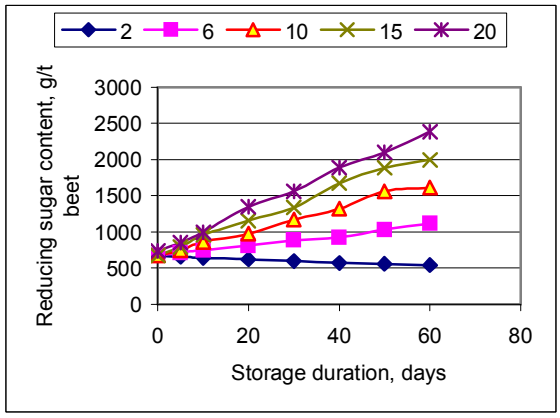


**Figure 5: Reducing sugar content of cultivar Markus stored at different temperatures**

In the case of the cultivar Markus there is a relative slow increase of the reducing sugars content in the first 20 days of storage, followed by an acceleration of this process in the range 20 – 50 days especially in the samples stored at 10, 15 and 20 $^{o}$C. The storage at 2 $^{o}$C has as effect a slight decrease of the reducing sugars content together with the increase of storage duration.

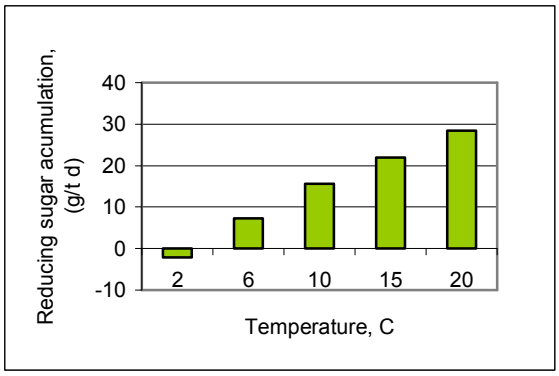


**Figure 6: Rate of invert sugar accumulation depending on temperature during storage (cultivar Markus)**

As can be seen from in figure 6, the accumulation rate of reducing sugars in the case of the cultivar Markus reaches maximum values at the ranges 2-6 $^{o}$C and 6-10 $^{o}$C and minimum ones at the ranges10-15 $^{o}$C and 15-20 $^{o}$C. This may be a particularity of the cultivar Markus making it adequate to be stored at higher temperatures.

The statistical analysis led to very high values of the correlation coefficient between the reducing sugars content and storage duration depending on the storage temperature:**Table 1: Correlation coefficient between reducing sugars content and storage duration depending on the storage temperature** :

| T, $^{o}$C | Victor | Soleia | Markus |
|---|---|---|---|
| 2 | -0.99545 | -0.99814 | -0.99626 |
| 6 | 0.99246 | 0.997655 | 0.996017 |
| 10 | 0.994762 | 0.998248 | 0.995082 |
| 15 | 0.99771 | 0.986814 | 0.995788 |
| 20 | 0.998926 | 0.991085 | 0.998649 |

The statistical analysis made shows very strong correlations of the same sense between the reducing sugars content and storage duration at the heat levels of 6. 10. 15 and 20$^{o}$ C. At the temperature level of 2 $^{o}$C the statistical calculation shows a strong correlation of opposite sense between the parameters analyzed.

## 4. Conclusion

After having analyzed the behavior of the cultivars selected at higher temperatures than 2$^{o}$C we have drawn the conclusion that the lowest accumulation rate of reducing sugars was registered in the case of the cultivar Victor stored at the temperature of 10$^{o}$C. This characteristic can be used in practice namely by programming batches of the cultivar Victor to get into production. at the end of the processing campaign having in view their capacity of preserving their technological capacity for longer storage periods of time. In the case of shorter time storage up to 20 days. the cultivar Soleia showed reduced accumulation rates. thus there is the possibility of planning their processing in the first weeks after being harvested. In the case of the 2 $^{o}$C –storage. a decrease of reducing sugars level in time was registered in all the cultivars analyzed. probably due to the invertase inhibition and consumption of the initial reserve of reducing sugars during metabolic processes.

These results lead to the conclusion that temperature is an important factor regarding the maintenance of sugar beet storage quality, the low temperatures being mainly recommended as closer as to the cryoscopy point of sugar beet root.

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