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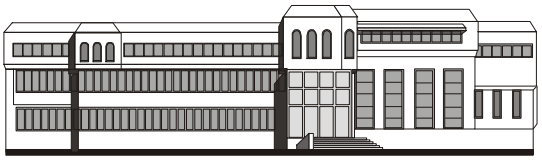
Faculty of Agronomy – Čačak
Cara Dušana 34, 32000 Čačak
e-mail: afdekanat@kg.ac.rs
www.kg.ac.rs



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X CONFERENCE OF AGRONOMY STUDENTS

***Participants*:**

1. University of Kragujevac, Faculty of Agronomy, Čačak, Serbia;
2. University of Belgrade, Faculty of Agriculture, Belgrade, Serbia;
3. University of East Sarajevo, Faculty of Agriculture, East Sarajevo, Bosnia and Herzegovina;
4. University of Sarajevo, Faculty of Agriculture and Food Sciences, Sarajevo, Bosnia and Herzegovina;
5. University St. Kliment Ohridski, Bitola, Faculty of Biotehnical Sciences, Bitola, Republic of Macedonia;
6. University Ss. Cyril and Methodius, Faculty of Agricultural Sciences and Food, Skopje, Republic of Macedonia;
7. University of Banja Luka, Faculty of Agriculture, Banja Luka, Republic of Srpska, Bosnia and Herzegovina;
8. Trakia University, Faculty of Veterinary Medicine, Stara Zagora, Bulgaria.
9. Agricultural University - Plovdiv, Faculty of Agronomy, Plovdiv, Bulgaria.
10. National University of Life and Environmental Sciences of Ukraine, Agrobiology faculty, Kyiv, Ukraine;
11. National University of Life and Environmental Sciences of Ukraine, Faculty of Economics, Kyiv, Ukraine;
12. Perm State Agricultural Academy, Faculty of Agricultural Technologies and Forestry, Perm, Russia;
13. State University of Novi Pazar, Serbia;
14. University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia;
15. University of Montenegro, Biotehnical Faculty, Podgorica, Montenegro;
16. Banat's University of Agricultural Sciences and Veterinary Medicine "Regele Mihai I al României", Faculty of Agriculture Timisoara, Romania;
17. National Pedagogical University of Dragomanov, Faculty of Historical Education, Kyiv, Ukraine;
18. Dicle University, Faculty of Agriculture, Diyarbakir, Turkey;
19. Mendel University, Faculty of Horticulture, Lednice, Czech Republic;
20. Szent István University, Department of Aquaculture, Gödöllő, Hungary;
21. Czech University of Life Sciences Prague, Faculty of Agrobiology, Food and Natural Resources, Prague, Czech Republic;
22. University John Naisbitt Belgrade, Faculty of Biofarming, Bačka Topola, Serbia;
23. University of Kragujevac, Faculty of Science, Institute of Biology and Ecology, Kragujevac, Serbia;
24. University of Priština, Faculty of Agriculture, Kosovska Mitrovica-Lešak, Serbia;
25. "Alexandru Ioan Cuza" University of Iasi, Faculty of Biology, Iasi, Romania;

The effect of frozen storage time on some parameters of sugar beet quality

Student: Aleksandra Korićanac
3 rd year of study (bachelor)
Mentor: Mirjana Radovanović
University of Kragujevac, Faculty of Agronomy Čačak, Department of Food Technology, Cara Dušana 34, 32 000 Čačak, Serbia,
e-mail: aleksandra.koricanac@yahoo.com

Abstract: The basic indicators of the sugar beet quality are amount of sucrose and non-sugar compounds. Sugar beet, since its arrival to sugar plant, should be processed in short time. However, for the purposes of extensive research, scientists can't analyze all parameters of quality during that short period of time. Thus, the effect of storage time and storage temperature on chemical properties of sugar beet should be examined. In this paper it was found that there were no significant changes in amount of sucrose and alpha-amino nitrogen during the 41 months storage at -18 °C. Based on amount of alpha-amino nitrogen it was clear that sugar beet from season 2012 was more suitable for processing than beet from season 2013. Sugar beet from both seasons (2012, 2013) belonged to the beet varieties with high contents of sucrose.

Key words: sugar beet, sucrose, alpha-amino nitrogen

Introduction

Sugar is produced in over 100 countries worldwide; 78% of the world's sugar supply is derived from sugar cane and 22% from sugar beet, mainly cultivated in industrialized sountries. The worldwide sugar production reached 160 million tons and total world sugar trade is projected to increase by 19,9% between 2010 and 2020 (Rezbova, 2013). Although sugar cane is still the world's no.1 crop for sugar production, its use for this purpose has been stagnating. On the other side, sugar beet shows both, qualitative and quantitative growth potential.

Sugar beet (*Beta vulgaris saccharifera*) is the only industrial plant, cultivated in temperate climates, which can be used for sugar production. Although sugar gives value to the sugar beet crop, the byproducts of sugar production, such as pulp, molasses, beet particulate and carbonation lime, give an added value. Molasses is one of the main raw material in processing and fermentative

industries, particularly for the production of baker's yeast. Due to good nutritive composition, sugar beet molasses is used as a supplement in feed production. The biggest world sugar beet producer is Russia with more than a million hectares of sugar beet yields and the main European producer in 2015 was France.

Since EU has deficit of 3-4 million tons of sugar per year, development of sugar beet varieties with maximum root and sucrose potential has priority. The sugar production in Serbia reached 400 000 t.

For profitable sugar production, sugar beet root must have certain chemical, morphological, biochemical and microbial properties. Quality of sugar beet depends on the content of sucrose and content of non-sugar compounds, primarly alpha-amino nitrogen, potassium and sodium. The sugar content in sugar beet can vary from 12% to 20% and according to European norms the sugar beet is marketable if it contains 14% sugar or more. Ideal efficancy of 130 kg sugar per ton of standard sugar beet processed at a sugar plant can be achieved only if sugar beet has a sugar content of 16%.

The sugar extraction rate depends on content of sucrose, potassium, sodium and alpha-amino nitrogen in sugar beet (Sklenar et al, 2000). Excessive fertilization and unfavorable agroecological conditions result in high amount of nitrogen compunds accumulated in sugar beet. High concentration of alpha-amino nitrogen decrease the yield of crystalization of sucrose. Thus, all nitrogen compounds present in sugar beet, except proteins (which can be precipitated during the process of purification) are marked as unwanted nitrogen.

Sugar beet should be quickly processed and according to this, experimental results about contents of sucrose and alpha-amino nitrogen in frozen sugar beet during different storage time at -18°C is impotrant for scientists, particularly for multiyear researches.

Material and methods

The alpha-amino nitrogen was determined using L-glutamine as standard for preparing series of calibration solutions in concentration range from 1,44 to 14,4 $mmolL^{-1}$. Other chemicals were:$Cu(NO_3)_2$, $Pb(CH_3COO)_2 \cdot 3H_2O$, PbO, CH_3COOH and CH_3COONa.

The copper reagent was prepared as follows: 250 g $CH_3COONa \cdot 3H_2O$ and 10g $Cu(NO_3)_2 \cdot 3H_2O$ were dissolved in a 1000 mL flask, filtrated and adjusted pH to 6 with concentrated acetic acid.

The stock solution of the base lead acetate was prepared as follows: 300g $Pb(CH_3COO)_2 \cdot 3H_2O$ was mixed with 100 g PbO. Then, a 1000 mL of distiled water without $CO_2$was added to this mixture. After standing for 7 days the solution changed its color to white or reddish-white, then filtered.

The diluted solution of the base lead-acetate was prepared by mixing 25 mL of a stock solution of the base lead-acetate with 975 mL of water.

The sucrose content was determined by a polarimeter (POL-1, Optic, Italy), and the alpha-amino nitrogen content by spectrophotometry (Photolab 6100 VIS, Germany). Samples were prepared by the method of cold digestion (Milić et al., 1992). 26.00 g of pulp sugar beet was mixed with 177 mL of diluted basic lead acetate. The mixture was transferred to a blender where the mixing time 3 minutes at 6000 r / min. After stirring the content was filtered and the resulting filtrate was used for the determination of sucrose and alpha-amino nitrogen. The concentration of sucrose in the filtrate determined from Biots Law:

$$\alpha^t_\lambda=[\alpha]^t_\lambda \cdot c \cdot l \qquad (1)$$

where: α^t_λ-degree read at polarimeter, °, $[\alpha]^t_\lambda$-a specific rotation of sucrose, which is +66.54 °mL$g^{-1}$$dm^{-1}$ at 20ºC and at a wavelength of 589 nm., c-sucrose concentration, gmL^{-1}, l-tube length, dm was used to calculate the content of sucrose in sugar beet. According to the above method, it is assumed that 26 g of pulp sugar beet containing 23 mL of juice, on the basis of which the weight of sucrose (g)/ the amount of L-glutamine (mmol) from the pulp are present in 200 mL of a solution (177 mL of basic lead acetate and 23 mL of sugar beet juice).

It was mixed 5 mL of a solution of L-glutamine of particular concentration, 5 mL of acetate buffer pH 6 and 2 mL of copper reagent. The intensity of the blue color of the complex formed amino acid and Cu^{2+} ions were measured at 600 nm, with distilled water as a reference value. The alpha-amino nitrogen in sugar beet was determined from calibration curve of L-glutamine based on the linear dependence:

$$A = f(c) \qquad (2)$$

where: A - the absorbance _red at spectrophotometer, c- concentration of L-glutamine, 1-mmol L^{-1}

Results and discussion

In this paper it was determined the content of sucrose and alpha-amino nitrogen in sugar beet from 2013 which was stored 41 months at -18 ° C. The results are compared with the results, which were obtained after 5 and 17 months of storaged the same sample of sugar beet at the same temperature. Also, it was compared contents of sucrose and alpha-amino nitrogen of beet from 2012 and 2013.

The sucrose content after 5 months of storage was 15.62 wt.% ± 0.41, after 17 months of 16.58 wt.% ± 0.67 and after 41 months of storage 15,62 wt.% ± 0.86 (Figure 1). Based on the value standard deviation measurements can be assumed that content of sucrose does not change during storage and that the differences were caused by experimental error. The sucrose content in the sugar beet in 2012 determined after 5 months of storage at -18 ° C was 16.48 wt.% ± 0.98. The difference in sucrose content of the beet from the 2013 and 2012 are in the range of experimental error, which can not express the assumption that sugar beet has a higher content of sucrose.

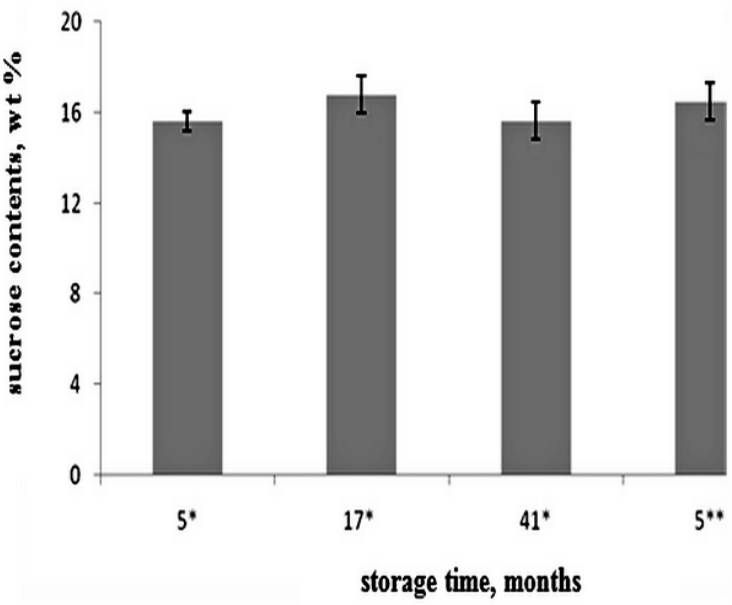

Figure 1. The sucrose content in function of storage time of sugar beet:
* from 2013 and ** from 2012

Jamaz (Jamaz, 2015) found that in 2012, despite the unfavourable_climate conditions, the average content of sucrose in sugar beet was the largest (15.1%) for a three-year period (from 2011 to 2013), while the sucrose content was depended by varieties of sugar beet and decreased in the following order: varieties *Belinda,Gina* and *Espirt,Chiara*. Due to lack of information about varieties of analyzed sugar beet, and to the high content of sucrose it can be assumed that sugar beet from 2012 and 2013 belonged to varieties with high sucrose content.

For precise determination of the alpha-amino nitrogen in the sample it was constructed calibration curve of the standard L-glutamine (Figure 2).

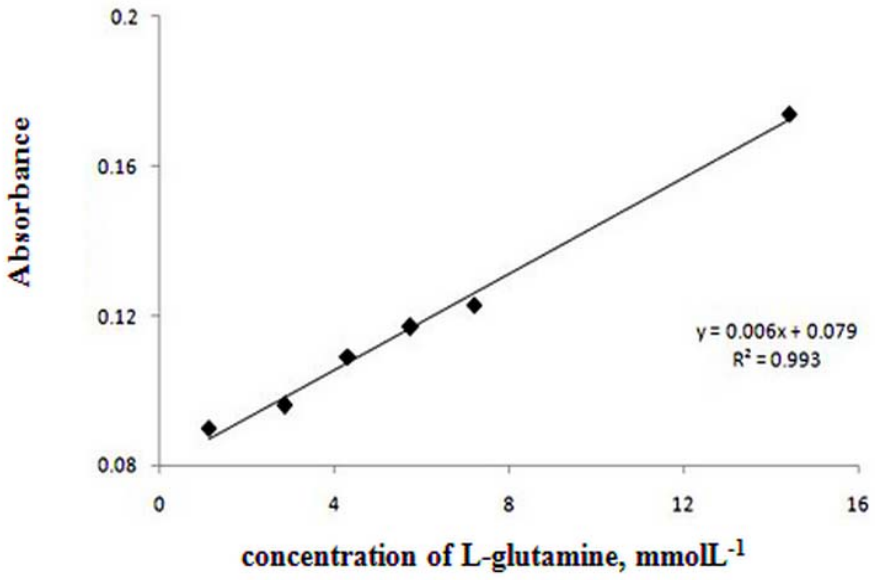

Figure 2. The calibration curve of L-glutamine

The content of alpha-amino nitrogen in the sugar beet was 4.21 mmolL-1 ± 0.39 after 5 months of storage at -18 ° C, 3.64 mmolL-1 ± 0.37 after 17 months of storage and 3.64 mmolL- 1 ± 0.42 after 41 months of storage at -18 ° C (Figure 3).

Based on the values of standard deviation can be assumed that there was no significant changes in amount of alpha-amino nitrogen storaged at -18 ° C. Sugar beet in 2012 after 5 months of storage had a significantly lower amount of alpha-amino nitrogen 1.66 mmolL-1 ± 0.31. It can be assumed that the sugar beet from 2012 was more suitable for processing because usually lower content of alpha-amino nitrogen because better utilization during the crystallization of sucrose.

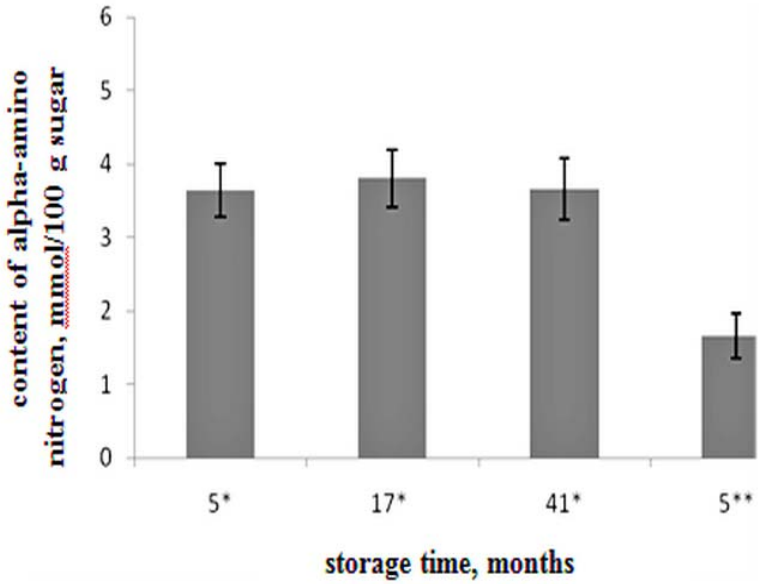

Figure 3. The content of alpha-amino nitrogen in function of storage time of sugar beet: * from 2013 and ** from 2012

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