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Physicochemical characteristics and mineral analysis of white sugar during Operation

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ABSTRACT

The purpose of this research is to investigate the physicochemical properties and mineral substances of sugar. In this plan, the effect of exploitation time in the form of months (October, November, December and January) and days (1, 10, 20 and 30) of exploitation of each month on the characteristics of sugar such as solution color, pH, Brix and ash content It was analyzed with analysis of variance test using spss 26 software. The results showed that the color of the solution, Brix, sugar percentage and ash content were significant ($p<0.05$). The results of the analysis of the technological quality of beet pulp selected from 8 different regions by Betalyzer showed that the results of the three elements sodium, potassium and nitrogen show that the sugar beets of region H have the lowest amount of the mentioned elements and the sugar beet of region B has the highest amount of elements in They had the amount of millimol/100 grams of sugar beet pulp. On the other hand, the results of the amount of alkalinity, percentage of sugar or sucrose, extraction coefficient and molasses are among the results of the technological quality analysis of the samples of sugar beet pulp by Betalyzer, respectively 8.56 for the samples delivered from region A and 3.03 for the samples delivered from region H. In terms of sugar percentage and degree of extraction, region F has the highest amount compared to other regions, so that the percentage of sugar was 18.72 and the degree of extraction was 89.41, which is in contrast to the beets received from regions E, which have the lowest sugar percentage (13.7). percent) and extraction degree (84.47).

1. Introduction

he production of light-colored and low-ash sugar from sugar beet or sugarcane is one of the primary goals of sugar manufacturing. The quality of white sugar is influenced by various properties, including its apparent color, color of sugar solution, microbial count, and ash content. These factors are in turn dependent on the quality and quantity of process line variables [1] .Color is a general term used to describe the many components that contribute to the visual color of granulated sugar. The two primary sources of sugar color are plant-derived pigments and pigments created during sugar processing. These pigments are composed of materials with varying molecular weights, pH sensitivity, ionic charge, chemical composition, and a tendency to combine with sugar crystals [2].Ash is another important parameter in sugar quality. It refers to the total mineral matter remaining after the organic matter of a compound is burned. Ash consists of soluble and insoluble salts of organic and inorganic compounds, mainly oxides and sulfates of potassium, sodium, calcium, and magnesium cations. In the sugar industry, ash content is of great importance and should not exceed 0.15% according to most standards, as it affects the final quality of the Part of the ash content from sugar beets is not removed during processing, and some is added during beet processing. Some can also come from the erosion of processing equipment. To prevent an increase in ash content, critical points of increase must be identified [3]. Ash content can be reduced by maintaining proper filtration, sufficient washing during centrifugation of sugar, and proper handling of sugar during drying and sieving. With decreasing sugar beet quality, ash content can increase, as a large part of the ash comes from soluble components in sugar beets that are not removed during processing [4]. Ash components such as calcium and iron play a role in color formation by catalyzing or preventing various reactions [5]. The role of ash components in color formation can depend on the color reaction taking place, pH, and temperature [6].

The technology of sugar production in the beet sugar industry mainly consists of several operational steps. In the raw section of the factory, the beets are carefully cleaned and impurities are removed. Then, thin slices are made from them [7]. This is how raw syrup is produced using the counter-current liquid-solid extraction method. Non-sugar soluble materials are precipitated from the raw syrup with calcium oxide, and after two-stage saturation with carbon dioxide and filtration of the precipitates, the resulting thin syrup is concentrated in evaporators [8]. In the sugar making section, sugar crystals are created by evaporative crystallization in consecutive operations. After the sugar crystals have grown sufficiently in the coolers, they are separated from the syrup and molasses by centrifuges. With the development of technological methods and equipment, these operations are carried out continuously, and the process factors and variables are controlled by automatic devices and sometimes by computer programs. While today, advanced process methods and equipment are used in all sugar factories [9].

The quality of white sugar depends on various product properties, which according to Iranian national and international standards include the appearance and color of the sugar solution, the ash content of the sugar and its microbial count. These properties are strongly dependent on the quality and quantity of the factors and variables of the process line. The importance of these properties is such that the grading of white sugar produced according to Iranian national standard number 69 also depends on them [10]. The working method and process operation variables are different in almost every factory. The reason for this phenomenon should be sought to some extent in the local history of the development of the factory's equipment and the economic management and control position of the process operations in the factory [5].

Although the quality properties and process value of the consumed raw material should not be overlooked. Many of the reasons for the difference in the quality and molasses yield of sugar from factory to factory, and even in one factory in one year compared to another, are related to the quality variables and control of the factors and variables of the process line [11]. The aim of this research is to investigate the physicochemical characteristics and mineral analysis of white sugar during operation time.

2. Materials and Methods

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2.1 Color Measurement Method

The color of the white or raw sugar solution was determined using a photometer. 50 grams of white or raw sugar were weighed in a wide-mouth Erlenmeyer flask. Then, 50 grams of distilled water was added, and the sugar was completely dissolved in the water using a stirrer. The resulting solution was filtered several times using Whatman No. 1 filter paper and adjusted to pH 7, 4, and 9. The filtered samples were poured into a 1 cm glass cell (cell 1). The spectrophotometer was set to a wavelength of 420 nm and distilled water was used to zero the instrument. The Brix value of the filtered solutions was determined using a refractometer [12].

The color of the solution was calculated using the following formula:

Brix density = (100 - (°Bx / 100)) / (1 + (°Bx / 100))

Where:

°Bx: Brix reading from a Brix refractometer

Steps to calculate:

1. Note the Brix reading from the Brix refractometer.
2. Divide the Brix reading by 100.
3. Subtract 100 from the result of step 2.
4. Divide the result of step 3 by 1 + (Brix reading / 100).

2-2 pH Measurement Method

A pH meter was used to measure the pH of white and raw sugar solutions. To ensure the most accurate measurement, the temperature of all solutions was adjusted to 20°C. The pH meter electrode was then placed in the solutions and the pH values of the samples were read from the instrument's monitor [13].

2-3 Brix Measurement Method

First, 50 grams of white or raw sugar were weighed in a wide-mouth Erlenmeyer flask. Then, 50 grams of distilled water was added and the sugar was completely dissolved in the water using a stirrer. The resulting solution was poured into the designated area of the refractometer according to the manufacturer's instructions. After the temperature of the sample was automatically adjusted to 20°C by the instrument, the Brix value was read. Finally, the sample was removed from the instrument using a suction device and cleaned with ordinary cotton [14].

2-4 Ash Measurement

To determine ash content using the conductivity method, 5 grams of syrup samples were weighed and placed in a volumetric flask. The flask was then brought to volume using deionized water and mixed thoroughly. Finally, the conductivity of the samples was measured using a digital conductivity meter (Model LF 538, WTW, Weilheim, Germany) at 20°C. The total ash was determined using the following formula [15]:

$$A_C\,(\%) = F_A \times (A_S - A_W) \times \left(\frac{4.5}{m} + \frac{Bx}{1000}\right) \times 0.0018$$

Where Ac is the ash percentage, FA is the correction factor, As is the electrical conductivity of the syrup sample (μS), Aw is the electrical conductivity of deionized water (μS), m is the mass of the syrup sample (g), and Bx is the concentration of soluble solids in the syrup sample (%).

2-5 Mineral Content Measurement of Sugar Beet Extract Using a Betabulator

This instrument was used to analyze sugar beet extract for potassium, sodium, sucrose, and alpha amino nitrogen. For this purpose, 26 grams of beet shavings were digested in 177 cubic centimeters of lead acetate solution and analyzed after filtration [16].

2-6 Statistical Analysis of Data

A completely randomized design was used to investigate the physicochemical properties and mineral analysis of white sugar during plant operation. Analysis of variance and mean comparison were performed using the least squares mean method at a 5% probability level.

The experiments were performed in triplicate and the statistical analysis of the results was performed using SPSS version 26 and the graphs were drawn using Excel.

3- Discussion and Results

3-1 Results of Technological Quality Analysis of Beet Pulp from 8 Different Regions Using a Betabulator

Eight samples were randomly selected (from each region) during operation and analyzed using a Betabulator. The results are shown in Table 1. As can be seen, there is a difference in the mean values of the elements in the beet pulp produced in regions A, F, E, and H and the surrounding areas. The Betabulator is a technological quality analyzer that is used to measure and analyze various characteristics of beet pulp. Here, the results of potassium, sodium, and nitrogen in beet pulp samples delivered to the sugar factory by the Betabulator are discussed and compared:

3-2 Results of Sodium, Potassium, and Nitrogen

The results show that the highest and lowest nitrogen contents belong to beet pulp from regions B-D and E, respectively. The recorded range is 04/7-26/4 millimoles per 100 grams of beet pulp. Its level can affect the quality of beet pulp and consequently sugar production. If the potassium level is higher than the permissible limit, the quality of beet pulp and consequently the quality of sugar may decrease. The sodium content was also obtained in the range of 86/2-63/1 millimoles per 100 grams of beet pulp for beet pulps from region H and E, respectively. Also, the nitrogen content was obtained in the range of 2/2 and 71/0 millimoles/100 grams of beet pulp for regions G and B, respectively. The results of the three elements show that beet pulps from region H have the lowest amount of the mentioned elements and beet pulps from region A and its surroundings have the highest amount of the elements in millimoles/100 grams of beet pulp. There are various non-sugar substances in sugar beet, but the role of some of them is more important than others. Among them, cations such as sodium and potassium and amides such as glutamine are the most important impurities in beet both quantitatively and qualitatively, which are not completely removed during the purification process and cause an increase in sugar and molasses [17].

In order to determine the effect of beet quality on industrial extraction, researchers have presented formulas to predict the extraction potential based on beet quality. The general basis of all formulas is the effect of harmful sodium, potassium, and nitrogen on molasses sugar losses. Among the various molasses sugar estimation (ZM) formulas, the Reinfield formula [1] and the Braunschweig formula [2] are more acceptable and are currently used by most sugar factories in the world.

The researchers' findings showed that the potassium content is at its highest level at the beginning of the growth period and decreases rapidly during the growing season. On the other hand, the sodium concentration is lower than potassium, but it also gradually decreases during the growing season. Harmful nitrogen has a lower concentration compared to the two mentioned elements and has more limited changes during the growing season [18, 19].

Nitrogenous compounds in sugar beet include proteins, amino acids, amides, nitrates, and nitrites. Most of these nitrogen-based compounds are eliminated or removed from the production stream with molasses through topping in the field and slicing in the beet mill. However, small amounts of them still appear in the extracted sugar [20].

A research report shows that sodium and potassium are very important cations for sugar beet growth. Sodium is sufficiently present in the soil, but the uptake of potassium added to the soil through chemical fertilizers is faster than that of other cations, which is why the concentration of potassium in sugar beet is higher than that of sodium [21]. In addition, potassium is considered an essential component for plant nutrition.

The results of various researchers show that sodium and potassium, which are called ash in the sugar industry, are very important indicators of sugar beet quality, and the higher their content, the lower the beet quality [5]. Since a large part of these materials enter the raw syrup through osmosis and part of it cannot be separated by the

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syrup purification section, they pass through all stages of the factory and enter the final molasses [22].

Table 1. Results of technological quality analysis of sugar beet dough samples delivered to the Sugar Factory by betalizer machine

Area code upload	% Sugar pol (%)	Na sodium (mmol/100 g pulp, sugar beet)	K, potassium (mmol/100 g pulp, sugar beet)	a-N nitrogen (mmol/100 g pulp, sugar beet)	Alc alkalinity (no unit)	Sugar Glucose sucrose (%)	Factor extraction Yield (%)	Molasses speciation SML (%)
A	10/93	2/42	5/37	0/91	8/56	17/7	88/79	1/63
B	20/57	2/51	5/69	1/61	5/09	18/12	86/09	1/58
C	16/33	3/33	4/26	1/86	4/08	13/89	85/08	1/84
D	17/99	2/86	7/04	2/19	4/52	15/2	84/47	1/84
E	16/18	2/81	5/66	2/33	5/26	13/7	84/66	2/19
F	20/94	2/05	4/77	2/81	5/13	18/72	89/41	1/88
G	17/05	2/52	5/45	2/2	4/59	14/55	85/35	1/62
H	18/61	1/63	5/04	0/71	3/03	16/2	87/06	1/9
Average:	18/45	2/55	5/41	1/69	5/03	16/01	86/61	1/84

On the other hand, the alkalinity level, sugar or sucrose percentage, extraction coefficient, and molasses formation were obtained as the results of the technological quality analysis of sugar beet pulp samples delivered to the sugar factory by the Betabulator. The results show that the alkalinity of the samples was 56.8 for the samples delivered from regions C and 03.3 for the sugar beet samples delivered from regions H. In terms of sugar percentage and extraction degree, regions B had the highest values compared to other regions, with a sugar percentage of 72.18% and an extraction degree of 41.89%. In contrast, sugar beets received from regions E had the lowest sugar percentage (13.71%) and extraction degree (47.84%). Therefore, the molasses formation percentage also increases, so that the results of Table 1 show that the highest molasses formation rate is from beets delivered from E (19.2%).

The results indicate that this can be due to weather conditions, soil conditions in terms of nutrients and salts, as well as the knowledge of farmers and the extent of their cooperation with agricultural engineers in terms of the method and amount of fertilization, harvesting time, and the method of transferring it to the factory. This can be effective in creating this difference in the salts and characteristics or technological quality of the sugar beet pulp samples delivered to the sugar factory in regions A by the Betabulator, which is consistent with the results of Heidari et al. (2008) [23].

Gohari and Khorasani (1993) in a study of different levels of nitrogen, phosphorus, and potassium observed that the highest root yield and white sugar production was related to the treatment of 150 kg of nitrogen per hectare, 120 kg of potassium, and 60 kg of phosphorus per hectare. In terms of extractable sugar, no significant difference was observed between the treatments of 150 to 375 kg of nitrogen per hectare. The results of this experiment also showed that the treatments had a significant difference at the one percent level in terms of raw sugar yield and root weight, but the effect of treatments was not significant for other traits [24].

Gohari et al. (1997) stated that with increasing nitrogen content, root yield increased, but sugar content and extractable sugar decreased. They did not observe any significant difference between the levels of 100 and 200 kg of nitrogen per hectare in their experiment [25].

Similarly, Jafari et al. (2015) reported in a similar study that in both regions, increasing plant density from 60,000 to 120,000 plants per hectare decreased potassium and sodium impurities in sugar beet roots. The application of 200 kg/ha of nitrogen fertilizer reduced the percentage of pure sugar in the roots [7].

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With the application of 100 kg/ha of nitrogen along with biological fertilizer and a plant density of 90,000 plants per hectare, the amount of sugar beet root impurities (sodium, potassium, and alpha amino nitrogen) decreased and the yield of pure and impure sugar increased. The relationship between the levels of impurities in sugar beet roots was positive and significant, while they had a negative and significant relationship with the percentage of pure and impure sugar. In general, the use of biological fertilizer in sugar beet cultivation improved the root quality characteristics and saved nitrogen fertilizer consumption [26].

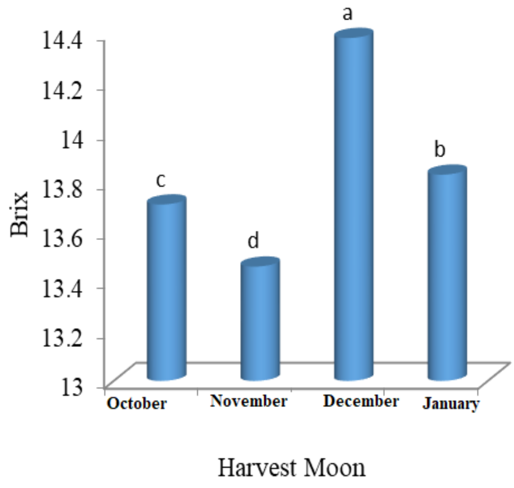
3-3 Results of variance analysis of changes in brix of white sugar produced from sugar beet sugar factory

According to the analysis of variance of the data obtained from the changes in brix (Table 2), it is clear that the effect of different treatments, month and day of sampling, and the interaction effect of these two factors on the brix of sugar samples were significant (P<0.05) (Figure 1).

Table 2. Variance analysis of changes in the percentage of Brix

Sources of change	Df	F value	P value
Moon (a)	3	474/953	0/000
Day (B)	3	213/813	0/000
Interaction (A×B)	9	0/733	0/000

The range of brix changes for the month variable is between 13.84 and 46.13. The brix of sugar produced in November was 13.84 and for October it was 46.13. In fact, the most changes occurred between October and November. According to Figure 1, there is a significant difference between all samples in terms of brix (p>0.05). The results of the effect of the days of operation also showed that the most changes are between the first and thirtieth days, so that the sugar produced on the first day of each month was less than the thirtieth day (13.69%) and reached 14.23% on the thirtieth day. This difference is significant at the 95% probability level.



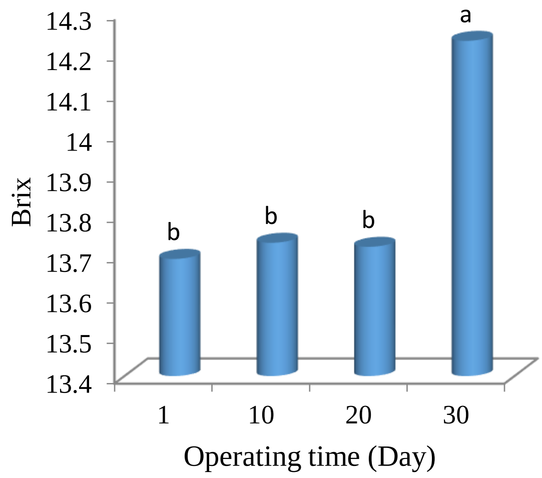


Figure 1. Changes in white sugar Brix during the harvest month and the day of operation at the Sugar Factory

Weather conditions can affect the physical and chemical properties of sugar beet, especially the percentage of soluble solids in water (Brix). Air temperature can affect the Brix percentage or solids of sugar beet and ultimately the percentage of soluble solids of the produced sugar. In warm and humid regions, ideal conditions are provided for sugar beet growth and its sweetness increases. As a result, sugar produced in warm and humid regions usually has a higher Brix percentage [27]. The amount of humidity in growing and harvesting conditions can also affect the physical and chemical properties of sugar beet. High humidity can increase the growth of sugar beet,

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but if the humidity is too high, it may lead to plant diseases and reduce the quality of sugar beet and the resulting sugar [28]. Rainfall can also affect the growth conditions of sugar beet and consequently the Brix percentage of sugar beet. Heavy rainfall may cause root rot and affect its quality. Other factors include the chemical composition of water. If the irrigation water contains a lot of salts, it may decrease or increase the Brix. Light intensity can also be indirectly effective. In such a way that the higher the light intensity, the better the growth of sugar beet in these conditions and its sweetness increases [28, 29]. Therefore, the significant difference in each sample in terms of Brix can be due to the presence of one or many of the mentioned factors.

3-4 Results of variance analysis of changes in ash percentage of white sugar produced by sugar factory

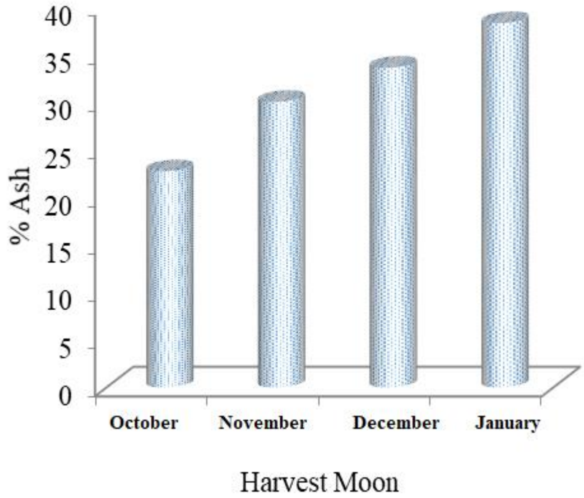
According to the analysis of variance of the data obtained from the changes in ash percentage (Table 3), it is clear that the effect of different treatments, month and day of sampling, and the interaction effect of these two factors on the ash percentage of raw sugar samples were significant (P<0.05) (Figure 3).

Table 3. Variance analysis of ash percentage changes

Sources of change	Df	F value	P value
Moon (a)	3	7220/16	0/000
Day (B)	3	1097/661	0/000
Interaction (A×B)	9	289/658	0/000

As can be seen, the ash content of sugar produced from beets harvested from October (22.72%) to late January (38.29%) increased, and this amount significantly increased from the first day (27.08%) to the thirtieth day (33.89%) of operation (P<0.05).

Various reasons can affect this increasing trend of ash, so that sugar beet processed in October can be significantly affected by weather conditions and its consequences compared to the following months. This can happen both during the exploitation in different months and when the sugar beet enters the factory and until the time of sugar extraction and utilization, in the sugar factory yard which is known as silo. Exposure to rain and sun can affect the changes in its minerals [3].



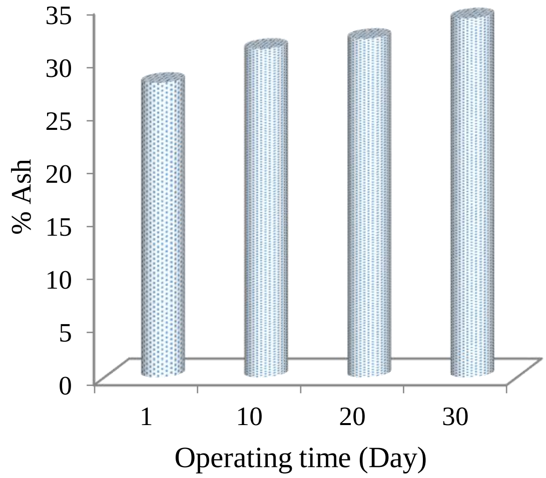


Figure 2. Percentage changes in white sugar ash during the harvest month and the day of operation at the Sugar Factory

If beets remain in the ground for a long time after reaching full maturity, they may absorb more ash, resulting in a higher ash content in the produced sugar. In general, the effect of harvest month on sugar ash can be different and depends on the different conditions of regions and beet

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growing and cultivation conditions. In general, the factors affecting the ash content of produced sugar are very extensive and numerous [5]. To reduce the ash content of produced sugar, attention should be paid to improving the cultivation, growth and sugar production process. It is also possible to use fertilizers with the lowest amount of mineral salts and control the amount of irrigation, fertilization and cultivation time [31]. In this line, Barga and colleagues (2021) conducted a similar study with a field experiment on the growth of sugar beet under the conditions of using solid and liquid digestate fractions with or without supplementation with phosphorus, potassium, magnesium and B. They found that the ash content of sugar beet roots in the treatment with the highest amount of phosphorus, potassium, magnesium and boron was higher than other treatments. Soil amendment with digestate supplemented with phosphorus, potassium and magnesium affected the quality parameters of sugar beet roots [26]. The increase in the following parameters was found under the application of enriched digestate: sucrose content, dry residue, pulp content, reducing sugars, α-amino nitrogen and amide fractions, as well as sodium and potassium content. A decrease in the ash content of conductivity was observed, but this difference was not constant. Enriching the digestate with phosphorus, potassium, magnesium and barium resulted in a beneficial modification of beet root processing parameters except for the predicted sugar content in molasses. In the case of the liquid fraction and its supplementation with phosphorus, potassium, magnesium and barium, six out of eleven technological quality parameters were increased [32].

3-5 Results of variance analysis of changes in the color of the white sugar solution produced by the sugar factory

According to the analysis of variance of the data obtained from the changes in solution color (Table 4), it is clear that the effect of different treatments, month and day of sampling, and the interaction effect of these two factors on the color of the raw sugar solution samples were significant ($P<0.05$) (Figure 4).

Table 4. Analysis of variance of solution color changes

Sources of change	df	F value	P value
Moon (a)	3	1112/044	0/000
Day (B)	3	423/727	0/000
Interaction (A×B)	9	7	0/000

As can be seen from (Figure 3), October (25.9) and the first day of operation (96.8) have the highest solution color among the months of harvest and days of operation.

Since the complexes and chemical compounds resulting from the combination of protein with invert sugar along with thermal reactions that lead to the production of caramel and melanoidin polymers are called solution color [26]. Therefore, based on the data obtained, these reactions have been affected by climatic conditions and operating conditions in the sugar factory [20, 33].

Since during storage and harvesting conditions in different months, there are factors affecting non-enzymatic reactions such as temperature, humidity, substrate, etc., and it is possible that the product is affected by factors for a long time and the color of the solution changes according to what is shown in (Figure 3). Saki and colleagues (2022) found similar results [34].

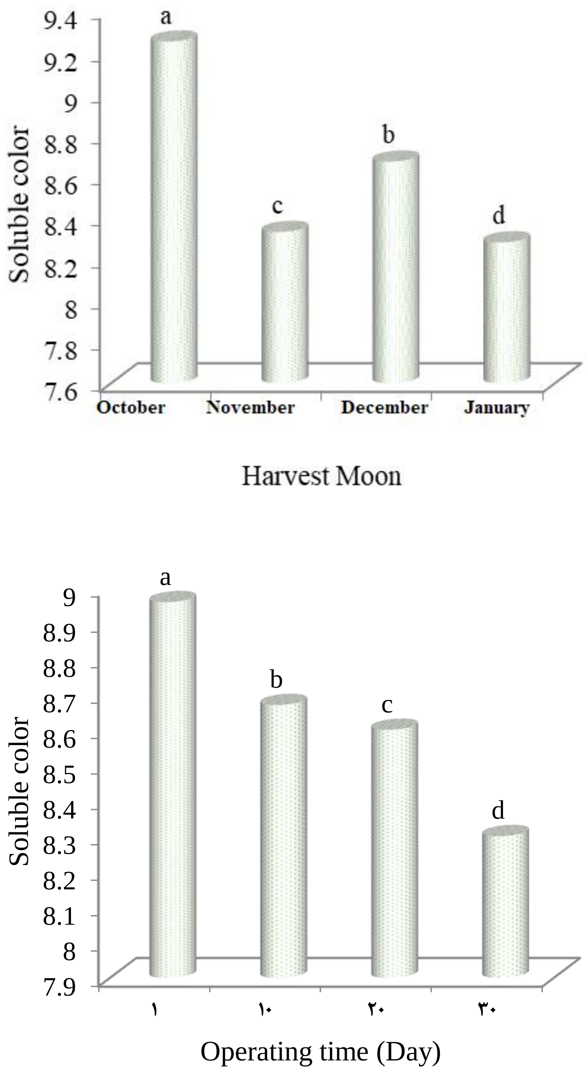

Figure 3. Changes in the color of white sugar solution during the harvest month and the day of operation

4- Conclusion

In this study, the main objective of the investigation was the effect of harvesting time (in the form of month and day) on the physicochemical and mineral properties of sugar. Therefore, various characteristics such as solution color, brix, pH, sugar content and ash content of sugar beet pulp were investigated during four different months (October, November, December and January) and on four different days of each month (1, 10, 20 and 30). The results showed that some of these characteristics, including solution color, brix, sugar content and ash content, were significantly affected by harvesting time. In other words, these characteristics showed significant changes over the months and on different days of the month. Analysis of variance using SPSS software was used to evaluate these effects. Also, using a betalyser, technological quality analysis of beet pulp from different regions was performed and the amounts of elements such as sodium, potassium and nitrogen in beets were investigated. The results showed that the amounts of these elements in beet pulp vary from region to region and these factors may play an important role in the technological quality of sugar. Finally, the results of the technological quality analysis of beet pulp samples also showed that characteristics such as alkalinity, sugar or sucrose content, recovery factor and molasses production also vary from region to region. These results can help in adjusting and improving sugar beet harvesting processes in different regions.

6- Reference

[1] Lima, I.M. and J.A. Beacorn, *Targeting a sustainable sugar crops processing industry: a review (Part I)—by-product applications.* Sugar Tech, 2022. **24**(4): p. 970-991.

[2] Zvyagintseva, A.V., S.A. Sazonova, and V.V. Kulneva. *Modeling of fugitive emissions of dust and gases into the atmosphere in open pits mining and processing plants, and improving measures to improve working conditions*. in *Proceedings of the Seventh International Environmental Congress (Ninth International Scientific-Technical Conference "(Ecology and Life Protection of Industrial-Transport Complexes" ELPIT 2019*. 2019.

[3] Baryga, A., B. Połeć, and A. Klasa, *Quality of sugar beets under the effects of digestate application to the soil.* Processes, 2020. **8**(11): p. 1402.

[4] Pirsa, S., et al ,*Hydrogels and biohydrogels: investigation of origin of*

production, production methods, and application. Polymer Bulletin, 2023. **80**(10): p. 10593-10632.

[5] Castro-Gerardo, G.A., et al., *Concentration and distribution of heavy metals in ash emitted by the sugar factory La Gloria, Veracruz, Mexico.* Revista internacional de contaminación ambiental, 2020. **36**(2): p. 275-285.

[6] Muir, B.M., *Sugar Beet Processing to Sugars*, in *Sugar Beet Cultivation, Management and Processing*. 2022, Springer. p. 837-862.

[7] Alena, A. and O. Sahu, *Cogenerations of energy from sugar factory bagasse.* Energy Engineering, 2013. **1**(2): p. 22-29.

[8] Bushnaq, H., et al., *Supercritical Technology-Based Date Sugar Powder Production: Process Modeling and Simulation.* Processes, 2022. **10** :(٢)p. 257.

[9] Ojha, K.S., et al., *Ultrasound technology for the extraction of biologically active molecules from plant, animal and marine sources.* TrAC Trends in Analytical Chemistry, 2020. **122**: p. 115663.

[10] Namini, N.Z., et al., *Hygienic quality of the honey samples produced in the Iran in comparison with international standards.* International Food Research Journal, 2018. **25**.(٣)

[11] Walayat, N., et al., *Role of cryoprotectants in surimi and factors affecting surimi gel properties: A review.* Food Reviews International, 2022. **38**(6): p. 1103-1122.

[12] De Whalley, H.C.S., *ICUMSA methods of sugar analysis: official and tentative methods recommended by the International Commission for Uniform Methods of sugar analysis (ICUMSA).* 2013: Elsevier.

[13] Farajinejad ,Z., et al., *A Review of Recent Advances in the Photocatalytic Activity of Protein and Polysaccharide-Based Nanocomposite Packaging Films: Antimicrobial, Antioxidant, Mechanical, and Strength Properties.* Journal of Polymers and the Environment, 2023: p. 1.١١-

[14] Nalbandi, H., S.S. Seiiedlou Heris, and P. Ahmadi Gheshlagh, *Determination of Optimum Performance Characteristics of Combined Infrared-Convectional Dryer in Drying of Banana Slices.* Agricultural Mechanization, 2021. **6**(1): p. 11-21.

[15] Argeh, A ,.K. Pirozifard, and S. Pirsa, *The use of clarifying materials in the purification of raw beetroot syrup.* Iranian Food Science and Industry Research Journal, 2018. **2**: p. 267-279.

[16] Serrano, J., et al., *Influence of imbibition temperature on the extraction stage of the cane sugar production.* Journal of Food Engineering, 2023. **345**: p. 111414.

[17] Duraisam, R., K. Salelgn, and A.K. Berekete, *Production of beet sugar and bio-ethanol from sugar beet and it bagasse: a review.* Int J Eng Trends Technol, 2017. **43** :(٤)p. 222-233.

[18] Merwad, A.-R.M., *Efficiency of potassium fertilization and salicylic acid on yield and nutrient accumulation of sugar beet grown on saline soil.* Communications in Soil Science and Plant Analysis, 2016. **47**(9): p. 1184-1192.

[19] Abdel-Motagally, F.M. and K.K. Attia, *Response of sugar beet plants to nitrogen and potassium fertilization in sandy calcareous soil.* Int. J. Agric. Biol, 2009. **11**(6): p. 695-700.

[20] Liu, L., et al., *Transcriptomic and metabolomic analyses reveal mechanisms of adaptation to salinity in which carbon and nitrogen metabolism*

is altered in sugar beet roots. BMC plant biology, 2020. **20**(1): p. 1-21.

[21] Abdel-Mawly, S. and I. Zanouny, *Response of sugar beet (Beta vulgaris L.) to potassium application and irrigation with saline water.* Ass. Univ. Bull. Environ. Res, 2004. **7**(1): p. 123-136.

[22] Mohammadi, F., et al., *Life cycle assessment (LCA) of the energetic use of bagasse in Iranian sugar industry.* Renewable Energy, 2020. **145**: p. 1870-1882.

[23] Heidari, G., Y. Sohrabi, and B. Esmailpoor, *Influence of harvesting time on yield and yield components of sugar beet.* J. Agri. Soc. Sci, 2008. **4**(2): p. 69-73.

[24] Gohri, J. and k. Klarstaghi, *Investigating some nutritional characteristics of sugar beet.* Research report. Sugar Beet Research Institute. Karaj, 2005(3): p. 5-10.

[25] Gohari, J., et al., *Determining the quantitative and qualitative response of sugar beet crop to nitrogen fertilizer and plant density*. Research report. Sugar Beet Research Institute. Karaj, 1997.

[26] Henke, S., A. Hinkova, and S. Gillarova, *Colour removal from sugar syrups.* Applications of ion exchange materials in biomedical industries, 2019: p. 189-225.

[27] Jahed, E., M.H.H. Khodaparast, and A.M. Khaneghah, *Bentonite, temperature and pH effects on purification indexes of raw sugar beet juice to production of inverted liquid sugar.* Applied Clay Science, 2014. **102**: p. 155-163.

[28] Al Zubi, H., et al., *Impact of some chemical treatments and length of storage on the storability of sugar beet.* International Journal of Environment, 2016. **5**(1): p. 96-106.

[29] Hassani, M., et al., *Genotype by environment interaction components underlying variations in root, sugar and white sugar yield in sugar beet (Beta vulgaris L.).* Euphytica, 2018. **214**: p. 1-21.

[30] Bhat ,S.A., J. Singh, and A.P. Vig, *Vermistabilization of sugar beet (Beta vulgaris L) waste produced from sugar factory using earthworm Eisenia fetida: Genotoxic assessment by Allium cepa test.* Environmental Science and Pollution Research, 2015. **22**: p. 11236–

.۱۱۲۵٤

[31] Djordjević, M., et al., *Modified sugar beet pulp and cellulose-based adsorbents as molasses quality enhancers: Assessing the treatment conditions.* Lwt, 2021. **150**: p. 111988.

[32] Baryga, A., B. Połeć, and A. Klasa, *The Effects of Soil Application of Digestate Enriched with P, K, Mg and B on Yield and Processing Value of Sugar Beets. Fermentation 2021, 7, 241*. 2021, s Note: MDPI stays neutral with regard to jurisdictional claims in published….

[33] Romano, A., *Seed Production and Certification in Sugar Beet*, in *Sugar Beet Cultivation, Management and Processing*. 2022, Springer. p. 91-120.

[34] Sakai, K., et al., *Synergistic effects of laccase and pectin on the color changes and functional properties of meat analogs containing beet red pigment.* Scientific Reports, 2022. **12**(1): p. 1168

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چکیده

هدف از این پژوهش بررسی ویژگی های فیزیکوشیمیایی و مواد معدنی شکر می باشد . در این طرح اثر زمان بهره بردای به صورت ماه (مهر، آبان، آذر و دی) و روز (۱، ۱۰، ۲۰ و ۳۰) بر روی خصوصیات شکر از قبیل رنگ محلول، pH، بریکس و میزان خاکستر با آزمون تجزیه واریانس با استفاده از نرم افزار spss, 26 بررسی شد. نتایج نشان داد که رنگ محلول ، بریکس، درصد قند و میزان خاکستر معنی دار می باشد (p<۰/۰۵). نتایج آنالیز کیفیت تکنولوژیکی خمیر چغندرهای انتخابی از ۸ ناحیه متفاوت توسط دستگاه بتالایزر نیز نشان داد که نتایج سه عنصر سدیم، پتاسیم و نیتروژن نشان می‌دهد که چغندرقندهای منطقه H از نظر عناصر مذکور دارای کمترین مقدار و چغندرقندهای منطقه B دارای بیشترین مقدار از عناصر را در میزان میلی مول/۱۰۰گرم خمیر چغندرقند دارا بودند. از طرفی نتایج میزان قلیائیت، درصد قند یا ساکارز، ضریب استحصال و ملاس زایی جزو نتایج آنالیز کیفیت تکنولوژیکی نمونه‌های خمیر چغندرقند توسط دستگاه بتالایزر به ترتیب ۸/۵٦ برای نمونه‌های تحویلی از منطقه A و ۳/۰۳ برای نمونه چغندرقندهای تحویلی از منطقه H ، از نظر درصد قند و درجه استحصال منطقه F نسبت به سایر مناطق دارای بیشترین مقدار بوده به طوری که درصد قند ۱۸/۷۲ و درجه استحصال نیز ۸۹/٤۱ بدست آمد که در مقابل چغندرهای دریافتی از مناطق E دارای کمترین درصد قند (۱۳/۷ درصد) و درجه استحصالی (۸٤/٤۷) می‌باشند.