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Effect of some chemical treatments on the quality and storability of sugar beet roots after harvest.

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Abstract: Thisinvestigationwas carried out to study the chemical and technologicalchangesof sugar beet roots during storage in open air after different chemical treatments(calciumhydroxide,sodium metabisulfite and sulfur dioxide). Samples of sugar beet roots were taken from the research fields of Delta sugar company, Kafr El-sheikh Governorate, Egypt during 2010 harvest season. The results revealed that the roots treated with $Na_2S_2O_5$ recorded the highest values of roots quality, and sucrose recovery.

Introduction: Sugar beet (*Beta vulgaris L.*) provides about 40% of the world sugar production. The importance of sugar beet is not only confined to sugar products but also for its secondary products **(Badawy, 1992)**. In Egypt, sugar beet is cultivated mainly in the northern part of Delta, where climate and soil condition are more suitable for high production. In most beet-growing areas, harvest periods are short and sugar beet storage is necessary. In all plants a small storage supply of beet is needed to transport the sugar beet to factory, which is a must, for effacing and operation nearly as possible to capacity at all time. A harvest beet is a living organism. Its respiration is important to maintain life. It is subject also to microbiological attack. The results of which is loss of sugar in stored beet. The rate of sugar loss increases exponentially as a temperature rises. Furthermore when a beet respires, it gives of heat. Often this causes a further rise of temperature, followed by even faster respiration. A temperature 7^{o}C, roots can become on appreciable factor, and the final result can be a complete loss. Fortunately, ways are known to minimize those losses.The present investigation was carried out to overcome the chemical deterioration and to extend the shelf life of sugar beet roots after harvesting and before processing and to study the chemical change in sugar beet roots during storage in open air after treating with chemical treatments $Ca(OH)_2$, SO_2 and $Na_2S_2O_5$ at different condition.

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Materials and methods

Sugar beet root, were obtained from the field of Delta sugar factory, Kafr El-sheikh Governorate, Egypt. Sugar beet roots were divided into four groups (100 roots of each group), stored for three days in open air after treating with following treatment. The first group without treatment (control) the second group was treated with calcium hydroxide solution at concentration of 1, 5 and 10 %, the third group was treated with sulfur dioxide at 500, 1000 and 2500 ppm (sulfur dioxide was obtained by burning sulfur in sealed cabinet), the fourth group was treated by sodium metabisulfite at 500, 1000, 2500 ppm durimg storage periods, temperature ranged from 18^{o}C to 31^{o}C and relative humidity from 55% to 85.5%. Analysis was carried out at 0, 1, 2 and 3 days of storage after harvest.

Methods: Moisture, reducing sugar, ash content, total nitrogen, fat, fiber content were determined according to **A.O.A.C (1990)**. Sucrose percentage was determined using saccharometer on lead acetate basis according to procedure of Delta sugar factory **(Le Docta, 1977).** Sugar recovery (S.R.), sucrose loss (S.L.) in wastes and quality were determined according to the procedure of Delta Sugar Company described by **Silin & Silina (1977) and Saponova *et al* (1979).**

Statistical analysis: Dataobtained were subjected to the statistical analysis system SAS.

Results and Discussions

Chemical composition data of fresh sugar beet is given in table (1). Moisture content of sugar beet roots was 78.39%. Similar result was recorded by **Mousa (1990)** and **Abou- Shady (1994)**. Sucrose content of sugar beet roots was 17.86 %. Similar result was comparable with those reported by **Badawy (1992)**, and **El-Sharnouby *et al* (1999)**. Low reducing sugar values of 0.78 was found in the roots at harvest. The present result is in agreement with the finding of **Rearick *et al* (1999)**. Table (1) show that ash content was 0.69 %. The obtained result is in agreement with **Gaber (1979)** who found that ash content was 0.57 % in roots of sugar beet at harvest. From the data shown in the same Table it could be noticed that total nitrogen was 1.04 % in the fresh roots. The present result is in agreement with data reported by **Abd-El Akher (1967), El-Geddawi (1988) and Abou-Shady (1994)**.

Table (1): Chemical composition of fresh sugar beet roots.

Compound	Moisture	Sucrose	Reducing sugar	Ash	Total nitrogen	Fiber	Fat	Total soluble solid
percentage	78.39	17.86	0.78	0.69	1.04	1.30	0.21	20.53

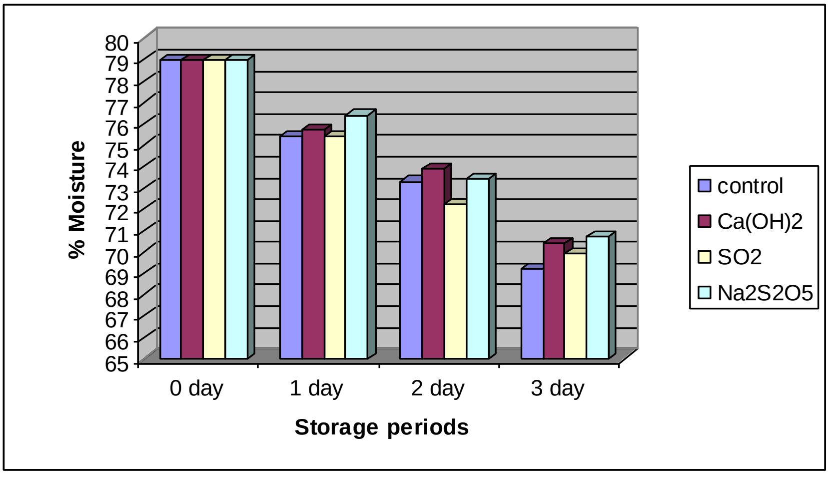
The result revealed that fat content was 0.21 %. Result is in agreement with those reported by Abd El Akher (1967) who mentioned that fat in sugar beet roots ranged between 0.20 and 0.50 %. Sugar beet contains relatively low fiber content of 1.30 % in the roots. Generally the percentage of fiber content was within the range of those found by Ibrahim (1970), Gaber (1979), Mousa (1990) and Abou-Shady **(1994)**. From the data in Table (1) it could be noticed that the total soluble solids content of roots was 20.53%. The present result is in agreement with the findings of **El-Geddawi (1988) and Abou-Shady (1994)**. The technological characteristics of fresh roots of sugar beet are shown in Table (2). Sucrose recovery of sugar beet was 14.68; sucrose loss in wastes was 3.18 %. Similar results were recorded by **Nassar (1992) and Hozayen (2002).** Juice purity and quality of sugar beet roots were 84.18 and 78.47 %; respectively. These results are in agreement with those reported by **Sarwar *et al* (2008)**. They reported that the juice purity and quality of sugar beet ranged from 81.14 % to 88.17 %.

Table (2): Technological characteristics of fresh roots of sugar beet.

Characteristics	Sucrose recovery	Sucrose loss in wastes	Juice purity	Quality of roots
Percentage	14.68	3.18	84.14	78.47

Effect of different chemical treatments on the chemical composition of sugar beet roots: The effect of different chemical treatments on the moisture content of sugar beet roots was studied and results are presented in Fig. (1). The results revealed that the moisture content of roots were significantly decreased during storage period. At the end of storage (3 days), the highest value of moisture content were observed by use of 500 ppm $Na_2S_2O_5$. The decrease in moisture content may be due to high temperature and high evaporation at the surface of sugar beet roots during storage. High temperature also could be a result of respiration. **El-Geddawi (1988)** found a positive correlation between temperature and moisture loss.

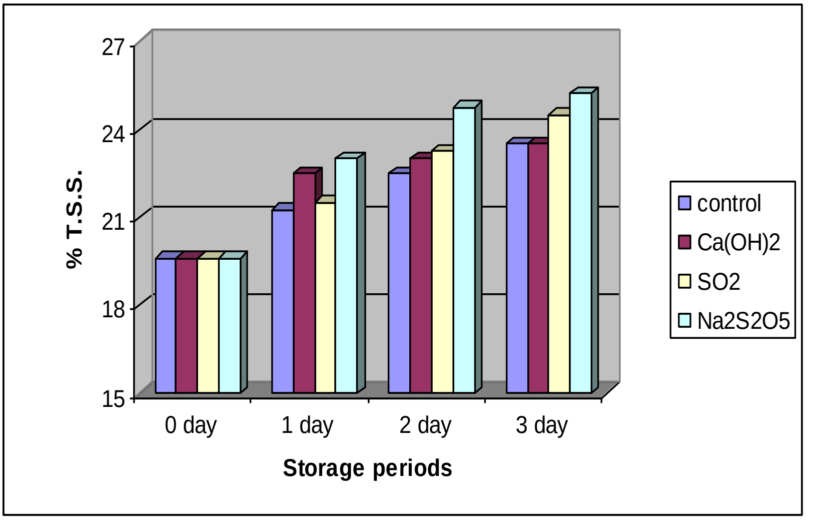
Fig. (1): Effect of different chemical treatments on the moisture content of sugar beet roots during storage.



LSD at .05 level = 2.756

The effect of different chemical treatments and storage periods on the total soluble solids content (T.S.S.) of sugar beet roots are given in Fig. (2). The results showed that the total soluble solids increased during storage by the use of all chemical treatments. These results are in agreement with **Abou-Shady (1994)** who observed that there was an increase in total solids during storage in four varieties under all storage condition and harvest dates. The values of total soluble solids at the end of storage periods ranged between 21.75 and 25.25 % by different chemical treatments. The use of 500 ppm $Na_2S_2O_5$ recorded the highest value of

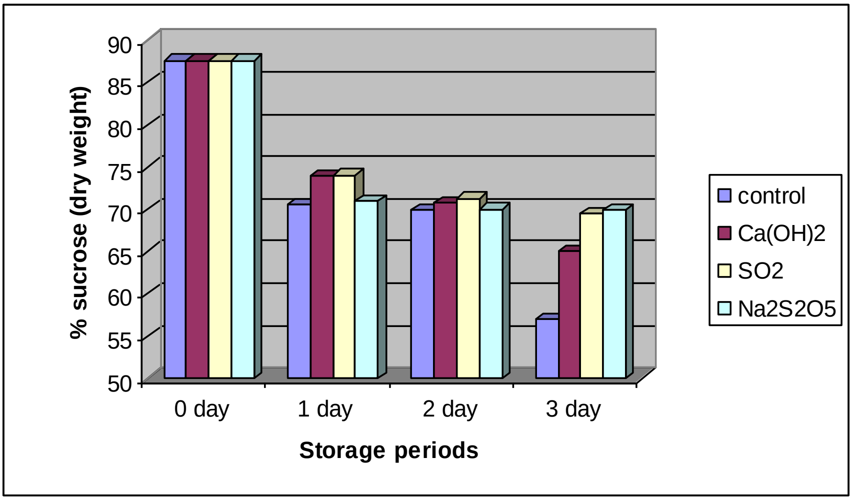
Fig. (2): Effect of different chemical treatments on the total soluble solids (T.S.S.) of sugar beet roots during storage.



LSD at .05 level = 1.301

total soluble solids (25.25%) after 3 days of harvest. The present results are in agreement with the findings of **El-Geddawi (1988)** who reported that the total soluble solids were increased under open air storage.The effect of different chemical treatments on sucrose content (dry weight) base of sugar beet roots has been studied. Data in Fig. (3) showed that sucrose content decreased during storage and by all chemical treatments used. Roots treated with 500 ppm $Na_2S_2O_5$ was recorded the highest value of sucrose content during storage (69.96 %). Chemical treatments decreased the loss of sucrose content, but not stopped it. This may be due to the action of microorganisms, respiration of roots and biochemical transformation of sucrose. The results of chemical treatments are in agreements with **McCready and Goodwin (1966)** who mentioned that sugar beet roots losses sugar during storage as a result of three different factors. The first is spoilage by microorganisms which used up sugar by respiration and produced enzyme which converted sucrose to invert sugars. Second, direct respiration by stored roots which change sugar in to CO_2 and H_2O and energy. The third source of sugar loss is through biochemical transformation of sucrose into invert sugar. The present results have the same trend with those of **Dilly *et al* (1970), Wyse and Dexter (1971), Josef *et al* (1978), Erick and Erling (1978) and El Gharbawy *et al* (1981).**

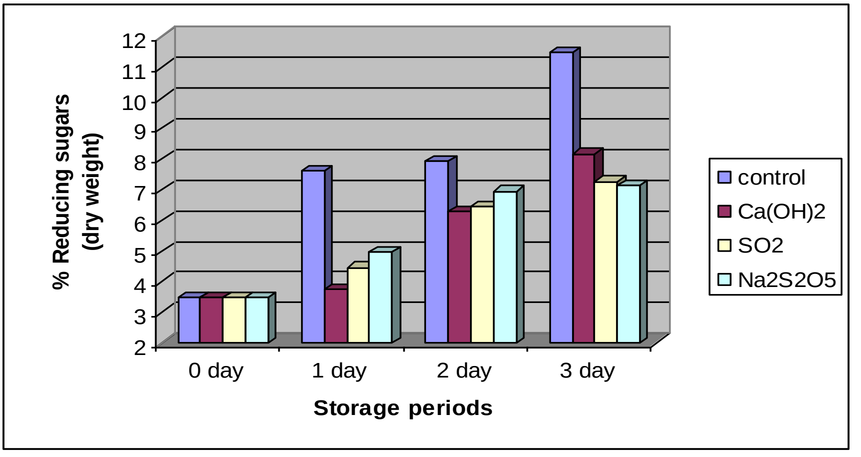
Fig. (3): Effect of different chemical treatments on sucrose content (dry weight) of sugar beet roots during storage.



LSD at .05 level = 4.485

It is well know that the lowest value of reducing sugars in the roots is the highest degree of quality. Reducing sugars are decomposed at a temperature higher than 55°C forming harmful stable dark decomposition products affecting the colour of sugar followed by an increase of lime salts which added to clear juice **(Ram, 1978)**. Roots with low reducing sugars content are easy for purification process which is subjected to beet juice. Reducing sugars in the juice play an important role and affect sucrose production especially during crystallization process. **Harvey and Dutton (1993)** reported that invert sugar is undesirable quality parameter because at the basal level in beet it breaks down in carbonation to yield acids and some colour. Both are melassigenic and any corrective sodium carbonate added by factory to minimize lime salts and to maintain pH >7 is melassigenic. At higher level, it represents sugar loss and greater acid and colour production.Study the effect of different chemical treatments and storage periods on the percentage of reducing sugars (on the base of dry weight) of sugar beet roots was carried out. The results indicated that the reducing sugars content of sugar beet roots increased during storage periods (Fig.4). The results outlined in Fig. (4) showed that control samples recorded the highest value of reducing sugar during storage period. On the other side roots treated with 500 ppm $Na_2S_2O_5$ recorded the least value of reducing sugar after 3 days of storage. Generally the present results of the changes of reducing sugars content during storage were comparable with those recorded by many authors as **Wyse (1974), Cole (1977), El-Gharbawy *et al* (1981) and Mousa (1990)**.

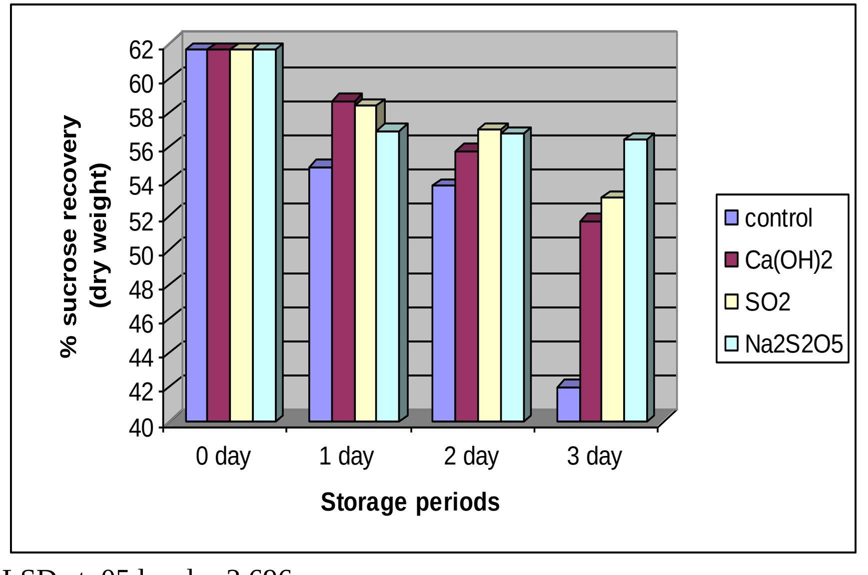
Fig (4): Effect of different chemical treatments on reducing sugars content (dry weight) of sugar beet roots during storage.



LSD at .05 level = 2.491

Effect of different chemical treatments on the percentage of sucrose recovery during storage was studied and the results are presented in Fig. (5) these results showed that the sugar recovery of all samples was decreased with different ranges. At the end of storage the roots treated with 500 pmm $Na_2S_2O_5$ recorded the highest values of sucrose recovery at the end of storage periods (56.44 %). This finding are in agreement with those of **Rorabaugh and Norman (1956)**.

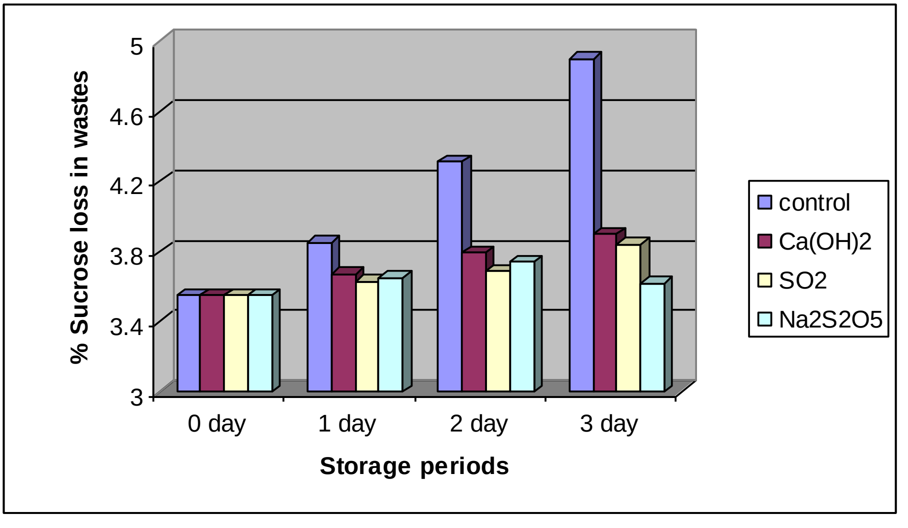
Fig. (5): Effect of different chemical treatments on sucrose recovery (dry weight) of sugar beet roots during storage.



LSD at .05 level = 2.696

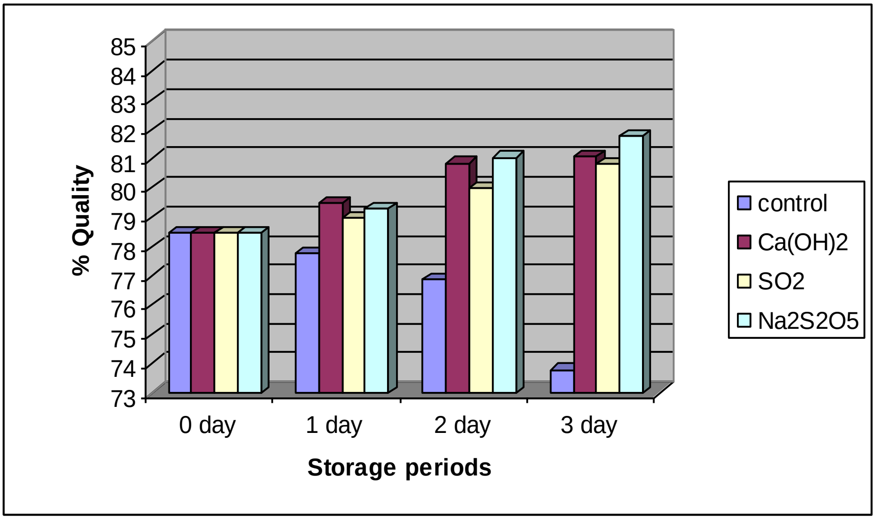
Percentage of sucrose loss in wastes were presented in Fig. (6). It could be noticed that the loss of sucrose in wastes was increased during storage in control samples as well as samples treated with different chemicals. The loss was higher in the control sample than other samples. At the end of storage period, the best treatment which gave the lowest value of sucrose loss was 500 pmm $Na_2S_2O_5$. While control sample resulted the highest values of sucrose loss in wastes. These finding are in agreement with those of **Abou-Shady (1994)** who reported that different methods of roots storage showed increasing of sucrose loss in wastes by increasing of storage periods.The effect of different chemical treatments at storage periods on the quality of sugar beet roots is given in Fig. (7) From the results of Fig. (7) it could be noticed that roots treated with 500 pmm $Na_2S_2O_5$ recorded the highest value of quality after 3 days of storage. These finding are in agreement with **Carter (1986).**

Fig. (6): Effect of different chemical treatments on sucrose loss in wastes during storage of sugar beet roots.



LSD at .05 level = 0.931

Fig. (7): Effect of different chemical treatments on the quality of sugar beet roots during storage.



LSD at .05 level = 2.678

The correlation of all characters of sugar beet roots after treatment with different chemicals was evaluated and presented in Table (3). From the data in Table (3) it could be noticed some relationship between some characters which can be used as quality indicators of some sugar beet roots. For example quality have a positive and high significant correlation with the sucrose (on the base of dry weight), sucrose recovery and total soluble solids. A negative and high significant correlation of quality with sucrose loss and reducing sugars (on the base of dry weight).

Table (3): Correlation matrix between some characters of sugar beet roots after different chemical treatment

	S.L.	**S.R.**	**Q.**	**Su.**	**R.S.**	**T.S.S.**
S.L.	1.000 0.0	** -0.390	** - 0.259	** - 0.294	** 0.441	** 0.373
S.R.	** - 0.390	1.000 0.0	** 0.336	** 0.887	** - 0.719	** - 0.474
Q.	** - 0.259	** 0.336	1.000 0.0	** 0.223	** - 0.052	** 0.330
Su.	** - 0.294	** 0.887	** 0.223	1.000 0.0	** - 0.820	** - 0.591
R.S.	** 0.441	** - 0.719	** - 0.052	** - 0.820	1.000 0.0	** 0.603
T.S.S.	** 0.373	** - 0.474	** 0.330	** - 0.591	** 0.603	1.000 0.0

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تأثير بعض المعاملات الكيميائية على جودة جذور بنجر السكر والقدرة التخزينية بعد الحصاد

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أجرى هذا البحث لدراسة التغيرات الكيميائية والتكنولوجية لجذور بنجر السكر خلال فترة التخزين تحت ظروف الجو العادى بعد معاملته معاملات كيميائية مختلفة(ايدروكسيد الكالسيوم، صوديوم ميتا باى سلفيت وثانى اكسيد الكبريت). تم الحصول على عينات جذور بنجر السكر من حقل أبحاث شركة الدلتا للسكر- محافظة كفر الشيخ- مصر خلال موسم الحصاد ٢٠١٠. تم تقدير التركيب الكيميائى للجذور وكذلك الصفات التكنولوجية لها قبل وبعد المعاملات الكيميائية. أشارت النتائج أن جذور بنجر السكر المعاملة بالصوديوم ميتا باى سلفيت أعلى جودة وسكر منتج.