Sudan university of Science and Technology

Collage of Science

Department of Chemistry

Production of sugar from sugar cane samples

إنتاج السكر من بعض عينات قصب السكر

Project Submitted for the fulfillment of the requirements of B.SC. (Honor) in Chemistry

By

salma Mohamed - RowaElageed - Tasneem Mohamed Algorashi

Supervisor

Dr. Omer Adam Gibla

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إستهلال

بسم الله الرحمن الرحيم

(إِنَّهُ مِن سُلَيْمَانَ وَإِنَّهُ بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ)

صدق الله العظيم

النمل (الأية 30)

Dedication

To our parents

To our brothers and sisters

To our Families

Acknowledgement

Our thanks to Allah for helping us by giving health to and wellbeing to perform this work successfully.

Our great thanks to our supervision Dr.Omer Gibla for his supervision and encouragement. Special thanks would also goes to ustaz Ali Eltaybe for his help and support

Abstract

The aim of This Study is was the production of sugar from sugar cane samples in the laboratory.

Sugar crystals were separated from cane juice of the cane samples, obtained from Elsuki area. Many tests were carried for the production of sugar, this include Molish test, Bendict test, Barfoide test and Selwanoff test.

The yield product was found to be 1.4168%.

المستخلص

الهدف من هذة الدراسة هو انتاج السكر من عينات من قصب السكر في المختبر

تم فصل بلورات السكر من عصير القصب لعينات تم الحصول عليها من منطقة السوكي.

اجريت عدة اختبارات علي الناتج شملت موليش، بندكت، بارفويد وسيلوانوف.

كانت نسبة الناتج 1.4168%.

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Chapter One

Introduction

1. Introduction

1.1 Description of plant

Sugar cane is a genius of Tropical grasses which requires strong sunlight and abundant water for satisfactory growth (1) as with most commercial crops there are many cultivars available to the cane farmer usually hybrids of several species.

Some varieties grow up to 5 meters tall the cane itself looks rather like bamboo cane and it is here that the sucrose is stored in the right climate the cane will grow in 12 month and when cut will regrow in other 12 months proved the roots are undisturbed although sugar cane proguce seeds modren stem cutting has become the mostcommon reproduction method each cutting must contain at least one bud and the cutting are sometime hand planting (2)

Sugar cane crop is sensitive to the climate soil type,irrigation,fertilizers,insects, disease control sugar cane forms lateral shoots at the base to produce multiple stems typically three to four meters high and about 5 cm in diameter(3).

1.2 History of the plant in Sudan

The Sugar Cane Cultivation Was Known since theOttoman region (1822—1885) lots of trail and experiments for cane sugar cultivation were carried all over the country.

In the area north of Khartoum the northern province and the south of Sudanfor the sake of producing JAGGARY and cane syrup for local consumption .but due to the increase in population and improvement in standard of living. the rate of consumption of sugar rise so the government planned to produce sugar locally as an import substitution to save hard currency and encourage intensifying the agriculture and improving the standard of living of the farmers and the area around to achieve that experiences used.

By come of (1962) GUNEID sugar factory at Gezira state (120KM south of Khartoum on the eastern bank of the Blue Nile River) started to work.

Not still along second factory built at NEW HALFA located 350 east of Khartoum at KASSALA state at 1965.

In 1975 SENNAR state seen the grown of sugar factory handle state name .Another factory was built in ASSALYA at White Nile state (300 KM of Khartoum on the eastern bank of the WhiteNile).

After a while these four factories mentioned above are managed under Sudanese sugar. As joint venture between government of Sudan, SAUDIA Arabia , Kuwait and other . KENANA sugar factory was built in 1980 which located on the eastern bank of white Nile 350 KM south of Khartoum.And to raise the production of sugar, afactory belongs to white Nile sugar Co. Has been fownded located at white Nile state about 200 km south of Khartoum (4)

Table 1.1 Detailed information sugar factories in Sudan

year	Factory name	Location	Total Area Ha	Irrigation system
1962	GUNEID	Gezira state	18000	Pump from blue Nile river
1965	New HALFA	KASSALA State	18000	Gravity from KHSHM ELGIRBA Dam
1975	SENNAR	SENNAR State	18000	Pumps from blue Nile river
1980	KENANA	KENANA State	45000	Pumps from White Nile river
2012	White Nile	White Nile State	45000	Pumps from White Nile river

Properties

Sucrose is a disaccharide produced by the condensation of fructose having the empirical $C_{12}H_{22}O_{11}$(molecular weight 342.30) Fig. (1-1): glucose and fructose structure

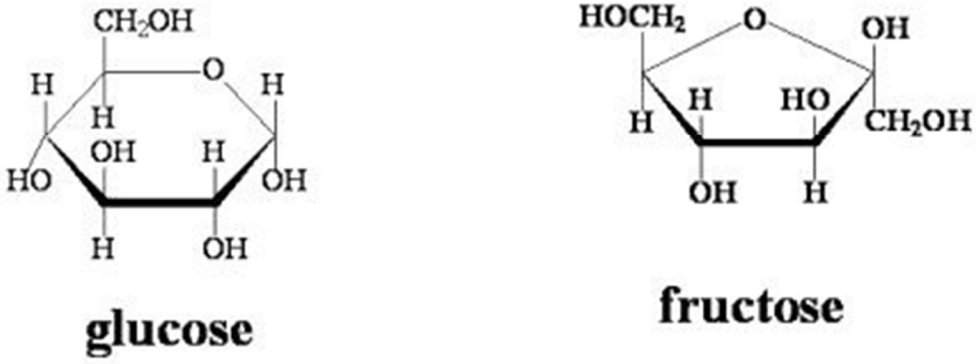

Fig. (1-1): glucose and fructose structure

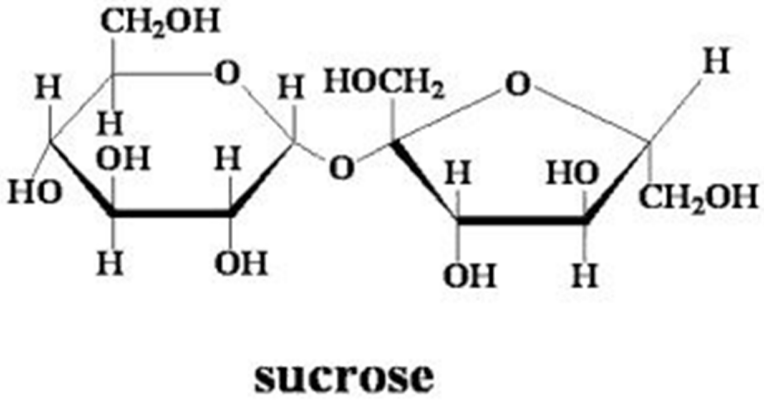

Fig. (1-2): sucrose structure

1.3.1 Crystallize form

Sucrose crystals are hard and anhydrous characterized by three unequal lengths.

Their density is equal to 1.606 g/cm^{3}impurities have a remarkable influence on the formation of the Crystal. Pure sucrose melts at 188 C (5)

1.3.2 Solubility

Sucrose is very soluble in water and in dilute ordinary alcohol it is insoluble in chloroform in cold absolute alcohol Ether and glycerin the solubility of pure sucrose in water increase with the rise in temperature of the solution.

Solubility decreases by the presence of a small quantity of organic but increase by large quantity of inorganic salts.

Also the Solubility of sugar in water changes with the purity of the solution but the variation depends upon the nature of the non – sugars consequently. (6)

The purity of the solution affects the solubility of the sugar at any given temperature

1.4 Chemical properties

1.4.1 Action of Heat on dry sugar

If heated for a long time at 160^{o}C, it splits up into glucose and fructose.

$C_{12}H_{22}O_{11} \xrightarrow{\Delta} C_6H_{12}O_6 + C_6H_{10}O_6$

(Sucrose) (Glucose) (Fructose)

1.4.2Action of heat on Sucrose solution

By Prolonged heating at boiling point , at ordinary pressure , the dissolved Sucrose slowly combines with water and breaks up into glucose and fructose

$C_{12}H_{22}O_{11} + H_{2O} \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$

342 18 180 180

(Sucrose) (Water) (D Glucose) (D Fructose) (7)

1.5 Sugar Manufacturing Process

1.5.1 Burning

Sugar cane field burning is carried out before harvesting the cane to make the process easier and require less manual labor .it take place during the harvesting Season, lasting from May to November (dry season) in the South and East.

With the peak of the burning season being in August, In the burning process the field is set fire to and the leaves are burned off of the stalk.

About 80% of the trash including straw, the tops, and green and dry leaves , are burned off. The burning kills microorganism and burn the trash, both of which keep the soil rich when left in the in the field, the practice burns scorpions,snakes, and bees which would otherwise be a danger to the laborers harvesting "green" (8)

Fig. (1-3) Burning of sugar cane field before the harvesting

1.5.2 Harvesting

Harvesting is done either by hand or by machine , cutting is a hard and dirty job but can employ lots of people in areas where scarce is cut at ground level , the top green level are cropped off and then the stalk is bundled whole . Once a complete bundle has been assembled it is removed from the field with a light cart and may then be transferred to a large vehicle for transport to the mill. (9)

Fig. (1-4a): Harvesting of sugar cane by hand

Fig. (1-4b): Harvesting of sugar cane by machine

1.5.3 Washing

The sugarcane that arrives the manufacturer is discharged to have the cleaner process; we add the table water for washing, removing solids or foreign matter like soil, salts, minerals, stones and others that are adhered to the same in thesoil when lifted to the cages that transport the same to the manufacturer. (10)

Fig. (1-5): Washing of sugar cane

1.5.4 Extraction

Juice extraction is not a simple operation, The juice is extracted from the cane ether by milling in which case the cane is pressed between heavy rolls or by diffusion in which case the sugar is leached out with water .In either case the cane is chopped into short segment and these segments passed through two sets of rotating knivesThe first set of knives cuts the cane into small pieces and also acts as a leveler.to distribute the cane more evenly on the carrier. The second set of knives acts as a shredder and thoroughly cuts up and shreds the cane into a fluffy mat of pieces.

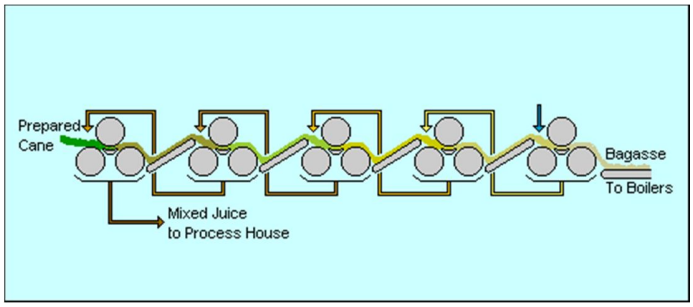

Fig.(1-6): Extraction process

1.5.5 Clarification

The juice which came from the mills is dark green- brown in color and acidic .it is heated just in excess of boiling point and milk of lime is added in two stages. Before and after heating (11). The purpose of adding the milk of lime is to prevent the inversion of sucrose

which takes place in acidic condition and to coagulate and precipitate impurities. The treated juice then enters the clarifier in which organic substance such as chlorophyll. Anthocyanin's .polyphenols. Wax. Gums albumin and pectin's, as well as calcium phosphate (formed by the milk of lime) coagulate to form floes and are precipitate as mud. Clarified juice straw colored and of low turbidity, is drawn from the top of the clarifier and sent to the evaporators. Mud is removed from the bottom. The mud still contain sugar which can be recovered, it is therefore mixed with bagacillo to make it cohesive. Sucked on to the mesh of rotary drum vacuum filters and sprinkled with water to elute more sucrose. The filtrate containing most of the muds residual sugar. Is returned to the clarifier. (12)

Fig. (1-7a): The juice from the extraction until the end of the clarification

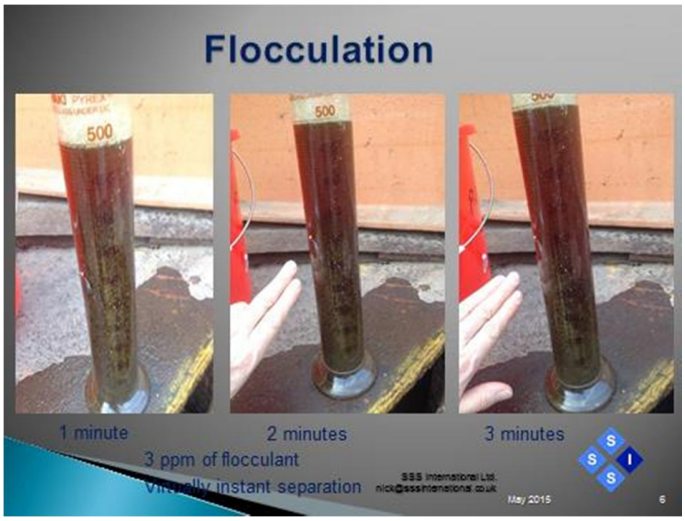

Fig. (1-7b): Coagulation and precipitation of the impurities after addition of lime

Fig. (1-7c): Separation of impurities in factory

1.5.6 Evaporation

The evaporation system operation in the plant is the fivefold effect, not only for the white line, but also for the raw line. The operation is quite simple because the entrance and exit conditions, level of each evaporator, and extraction of vegetative vapor toward the exterior are established.

The evaporation is carried out in Roberts's type evaporators in which the vapor and juice are found in separate chambers that flow in the same direction. The juice goes from one evaporator to another with pumps known as "of transfer". The global control of an evaporator is executed through the stabilization of five very important factors:

- The concentration of the final product
- The absolute pressure in the last body
- The vapor and juice feeding to the first evaporator
- Removal of condensates and airborne gasification
- The embedding control in each evaporator

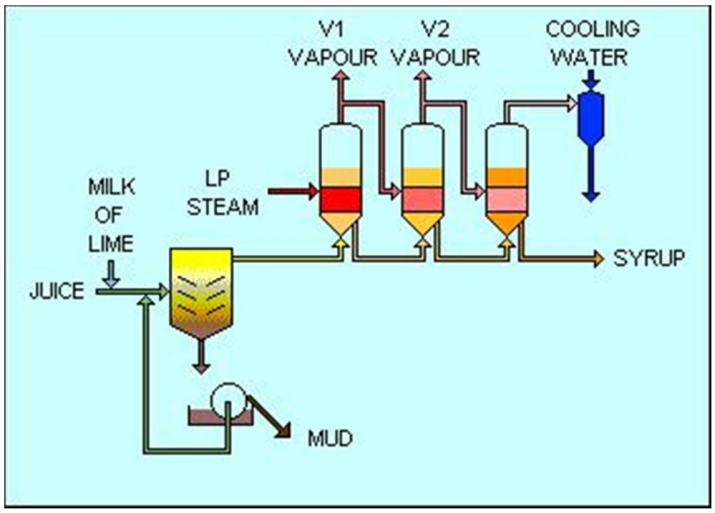

Fig. (1-8): Concentration of juice (evaporation)

1.5.7 Crystallization

The sucrose crystallization or growth that contains syrup is carried out in vacuum container this cooking, according to its purity, will produce raw sugar and white sugar. This is a delayed process that is accelerated industrially introducing a few microscopic grains of sugar, known as seeds, into the container. The operator's experience should judge the exact cooking point to obtain a good product.

1.5.8 Separation

The sugar crystals are separated from the honey left in the centrifuges; cylindrical Equipment that rotates at a high speed. The honey passes through the fabric; the crystals are trapped within the centrifuges and then washed with water. The honey is then returned to the containers or used as raw material for the production of alcohol in the distillery. The sugar is then transferred to the drying and cooling process.

1.5.9 Refining

Regarding the production of refined white sugar, there is an additional process that uses standard white sugar or raw sugar as raw material.

In this process, sugar at 60 brix degrees is dissolved. Then, activated charcoal and diatomaceous earth is added. This solution undergoes a first and second filtration in vertical filters until obtaining clear liquor. The liquor is evaporated and thecrystallization of crystals started.

1.5.10 Drying

In the centrifuge process, condensate water is used to wash sugar, which results in a humidity between 0.3% and 0.6%; therefore, it is necessary to pass it through the drying process to reach levels between 0.2% for raw sugar and 0.03% for white sugar

Fig. (1-9): Sugar Crystals

1.5.11 Packing

Export raw sugar goes directly from the dryer to the storage warehouses. In thewarehouses, it is loaded in trucks that transport the same to the shipping port. Standard white and refined sugars are packed in sacks of 50 and 46 kg and jumbos of 1400kg to be commercialized locally and internationally .(13)

Chapter Two

Materials and methods

2- Materials and methods

2.1Materials:

Cane Sugar samples were collected from Elsuki Market

2.2 Chemicals:

Ethanol (absolute 98%), α −naphthol, Sulfuric acid, Benedict's solution, Barfoid solution, Selwanoff solution

2.3 Instruments

Water Bath:

Rate: 230V, 50/60 HZ Fuse : 250V (T15AL)،

Electrical Heater: Single plate of 140 mm, operating on/off, indicator light Auto-thermostat various heat operations

Over heat protection Non – stick coating Power: 1000 W

2.4 Methods of analysis

2.4.1 Production of sugar

The juice was but in a beaker (2liter) then heated until the volume decrease to 65% then the concentrated juice was left to 10 min and dissolved in absolute ethanol until the solution became clear with some Molasses on the bottom of the beaker.

The beaker was but on water bath for 5 min, after that the clear solution was separate from the molasses by decantation Then it was but in a conical flask, covered and left for several days .the formed crystal was filtered , washed with ethanol , dried and weighted , the percentage yield of the formed sugar crystals was calculate.

2.4.2Molish's test

- 1 ml of test solution (sucrose) was added to test tube
- 2 to 3 drops of alpha naphthol was added
- 1 ml of H_2SO_4 was added

2.4.3 Benedict's test

- 2 ml of benedict solution was added to the test tube
- 4 drops of test solution was added mixed gently
- it was heated at boiling water bath for 5 min

2.4.4 Barfoid test

- 1 ml of barfoid solution was added to clean dry test tube
- 0.5 ml of test solution was added
- heating at boiling water bath for 10 min

2.4.5 Selwanoff test

- 1 ml of selwanoff solution was added to test tube
- 0.5 ml of test solution was added
- heating at boiling water bath for 5 min

Chapter three

Results and discussion

3-Results and discussion

Table 3-1: Physical properties of the produced sugar

Produced sugar	Results
Test	Sweet
Shape	Crystals
Size	medium
Color	Pale yellow

Table 3-2: Chemical properties of the produced sugar

Test name	Observation	Result
Molish test	A violet ring was formed	It is a carbohydrate
Benedicts test	No change was given	It is not reducing sugar
Barfed test	No precipitate was formed	It is di saccharide
Selwanoff test	Red color was formed	It is a ketone sugar

Table 3-3: The weight of the produced sugar

Weight of cane	Weight of sugar crystals
2.5 kg	0.03542kg

$$\% = \frac{\text{Weight of sugar crystals X 100}}{\text{Weight of cane}}$$

$$\% = \frac{0.03542 \text{ X } 100}{2.5} = 1.4168\ \%$$

3.2- Discussion

The percentage of yield of sugar was found to be 1.4168 %

The percentage of yield depend on the type of the cane and the technique used on the production.

Fig. (3-1): the produced crystals

Comments and Recommendations

Comments

In MOLISH test a violet ring is form due to the reaction with $H_2SO_4$to form furfural which Condense with alpha naphthol to form the violet ring.

Benedict solution when it react with sugar it give green color when sugar reduce copper ion (¡¡) to cupper (¡) .

But in BARFOED the sugar does not react with it because it is di Saccharides.

In SELWANOFF red color appears due to the reaction of sugar with HCL to form furfural which condenses with resorcinol to give the red color.

Recommendations

It may possible to produce sugar crystals from sugar cane by ethanol as follows:

1- The cane should not keep for long time to prevent the dryness of juice in it.
2- The juice most keep in a cold place and not for long time to prevent the fermentation
3- The ethanol used for crystallization must be absolute to prevent the dissolving of sugar
4- Thebeaker which contains the juice must be covered during heating to prevent the evaporation of ethanol.
5- The produced sugar must keep away from moisture

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