Quality of Affined Sugar at Different Temperatures

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Abstract

The study is done to evaluate the quality of the sugar produced from the affination processes after applying different temperature 60 ˚C, 70^{o} C and 80^{o}C, and study the chemical and physical properties of affined sugar .From the results it is clear that the appropriate temperature at 70^{o}C. Atthis temperature, it gives highest de colorization and polarization, less in polysaccharides content (dextran), reducing sugar and ash ratio.

Keywords: Raw sugar, Affination, Temperature, Dextran, Decolorization.

1. Introduction

Raw sugar crystal is covered with a film of molasses containing impurities and coloring matter, the average purity of this film is about 70%, the film can be removed very easily by affination(1). Affination processes means that treatment of raw sugar crystals with a concentrated syrup to remove the film of adhering molasses, this is achieving by mixing sugar with syrup and then centrifuging the magma with or without water washing (2). Generally, there is a relationship between the quality of raw sugar and the difficulties in turning it into good quality white sugar (3). There are some factors affectingon the efficiency and effectiveness of the affination process such as:
Crystal grain size, moisturecontent andimpurities in rawsugar (4).

In this paper, the effect of the temperature on the affination process and the quality of affined sugar has been studied. In sugar

refineries, the temperature of the magma may be varied according to the raw sugar impurities ranged from 60°C to 75°C [2].

2. Materials and methods.

2.1. Materials.

Accumulating representative samples of raw sugar supplied from Brazil to the Hawamidiya refinery sugar factory, the samples were collected to representative 100,000-ton raw sugar. A number of ten samples were collected to study the chemical and physical properties, and there was convergence in all properties except for the dextran ratio in sample number five and nine, so the study was done on them.

2.2. Methods.

2.2.1. Analytical methods.

Polarization, reducing sugar, ash, moisture, starch and color determine according to ICUMSA (2017) methods [5].

Safety factor, which are related to the moisture content of raw sugar, serve as quality criteria for raw sugar storage [2]. The safety factor found by Whalley [6] is defined as

$$SF = \frac{moisture\ (\%)}{100 - polarization}$$

2.2.2. Roberts method for determination dextran

This method can be used for raw sugar and refined sugar, can juice, syrups, and molasses. It is a quantitative method for total dextran, in which all of the polysaccharides are separated from the sugar by precipitation with 80% ethanol, and dextran is selectively precipitated from the polysaccharides mixture with alkaline copper sulfate. The dextran in the precipitate is then determined calorimetrically [(7)]. A device was used spectrophotometer jenway model 6300.

Preparation of standard curve by using standard dextran Mr- 70000, dextran from leuconostoc spp.

The dextran is precipitated from 40 gram of raw sugar, and applying the steps of the Robert method [7]. Moreover, applying this equation to can be estimated the dextran in sugar samples.

$$\mathbf{ppm = F \times E \times \frac{C}{D} \times \frac{1}{B} \times \frac{100}{A} \times 1000}$$

Where A =wt of sample solid diluted to 100ml
B = aliquot taken for alcohol precipitation (ml)
C = ml of solution of alcohol precipitate
D = aliquot taken for copper precipitation (ml)
E = ml of final solution of copper –dextran complex
F = mg/ kg dextran (from standard curve)

2.3.3. Affinaion methods

This method is applicable to all raw sugar toremove the film of molasses coating of sugar crystal.

Sugar solution (saturated)

Add 300 g distilled water to 700 g refined sugar in a 2 L beaker. Stir at room temperature until no further sugar dissolves (approximately 12 hours). Check that the solution is saturated by measuring the Brix (the sucrose saturation point at 20°C is ± 66.6°Bx). Filter the syrup through coarse calico or other cloth to obtain approximately 850 cm3 of syrup[8].The solution is then heated in water bath to the desired temperature 60^{o}C, 70^{o}C and 80^{o}C,will be added the solution to the samples with heating to keep the heat and stirring simples without dissolving the crystals.

Weigh 1200 ± 10 g raw sugar into wide-mouthed container. Add 1000 cm^3 of the saturated sugar solution, using the measuring cylinder. Screw the lid on tightly and tumble at 20 rpm for 30 minutes. Pour the magma in a steady stream into the centrifuge basket spinning at 500 - 1 000 rpm.

Wash the sugar with 50 cm^3 cold distilled water using a wash bottle with a fine jet. Increase the speed to 3500 ± 200 rpm and spin for 6 minutes. stop the centrifuge and remove the basket [8].

The sugar yield from centrifuge was dried, and determined all physical and chemical properties.

3. Result and Discussion

Table 1. Analysis sample of raw sugar

Sample	Moist %	Safety factor	Polarization (Z̊)	Starch (ppm)	Dextran (ppm)	Reducing sugar %g	Ash % gm	Reducing sugar /ratio ash	Color (IU)
1	0.07	0.13	99.45	386	485	0.14 [	0.11	1.3	670
2	0.07	0.11	99.36	370	350	0.15	0.11	1.4	662
3	0.08	0.13	99.38	385	425	0.17	0.12	1.4	653
4	0.06	0.09	99.35	400	323	0.16	0.11	1.5	655
5	0.06	0.11	99.45	385	525	0.16	0.12	1.3	675
6	0.07	0.11	99.35	401	343	0.16	0.11	1.5	660
7	0.07	0.10	99.32	380	360	0.14	0.11	1.3	680
8	0.07	0.11	99.35	375	362	0.17	0.11	1.5	710
9	0.06	0.11	99.45	385	548	0.15	0.12	1.3	690
10	0.07	0.10	99.28	410	325	0.14	0.12	1.2	660

Table1illustrates the following items:

Moisture

The moisture of raw sugar is probably the most important parameter determining its stability and keeping quality during storage [9]. Destruction of sugar by osmophilic yeasts could take place in the syrup film surrounding the crystal providing conditions that are appropriate and sufficiently diluted[3]. The relation shape between moisture and non-sucrose in raw sugar expressed in terms of "the safety factor"

Polarization

Polarization of raw sugar ranged from 99.25 to 99.45. Polarization is an important parameter in raw sugar. The higher polarization of raw sugar mean lower the impurity load on the refinery , and the higher the refined sugar output or yield per ton[9]. Generally, in raw sugar payment systems one of the primaries is polarization.

Starch

The samples contain high starch content, starch occurs naturally in cane as smell granules, it can be easily removed by filtering, when the largest granules readily gelatinized and increase viscosity. About 30% of the starch in juice eventually appears in raw sugar crystal [9]. In the carbonation refining process, it interferes with the precipitation and coagulation of calcium carbonate crystals. This results in poor filterability after clarification [11].It is generally accepted that starch level exceeding 250ppm raw sugar cause refinery problem[9]. In these samples from the sugar-refining factory in Hwamadia, Egypt, starch analyzes are higher than250ppm, which lead to a problem in refining processes**.**

Color

The results showed that color value ranged from 650 to 710 IU, and the results are considered convergent. The color in raw sugar plays an important role in sugar refinery [12].color removal is the basic principle of sugar refining and the proportion and nature of the colorants in the raw sugar that can determine the cost of refining.

Dextran

Dextran Content ranged from 323 to 548 ppm, dextrancauses many problems in sugar refining which cause slow the rate of filtration of refined liquors and reducing factor capacity[2].Dextran in final refined sugar also causes problems for the producers of sugar containing products, especially hard candies and cordial liquors[10].

Ash

Affination is the main ash remove process, in the carbonation process and de colorization by bone char can remove a small amount do residual ash in affination process [11]. The ratio of ash in samples ranged between 0.11 to 0.12 %gm, some authors have specified 1000 mg/kg as the maximum level for ash in affinated sugar, and other quotes a lower ratio from 300 to 400 mg/kg [9].

Table 1 illustrates that the safety factor ranged from (0.09 to 0.13) in which the safe limit is 0.25[2], therefore all samples less than limit, and thus the sugar could be stored without danger.

Table 2. Affination process at temperature (60°C)

Content of sugar	Sample 5		Sample 9	
	Raw sugar	Affined sugar	Raw sugar	Affined sugar
Polarization Z	99.45	99.55	99.45	99.50
Dextran ppm	525	380	548	392
Starch ppm	385	380	392	385
Ash %gm	0.12	0.03	0.11	0.04
Reducing sugar%gm	0.16	0.09	0.14	0.07
Color IU	675	588	690	600

Table 2 shows that the affination process at temperature 60°C, increases the polarization by 0.05 to 0.1, and higher polarization leads to an improvement in sugar quality and an increase in refining output.

Decreased the ratio of ash, reducing sugar and color but starch is still almost unchanged. Dextran decreased by up to 27%.

Table 3. Affination process at temperature70^{o}C

Content of sugar	Sample 5		Sample 9	
	Raw sugar	Affined sugar	Raw sugar	Affined sugar
Polarization Z^{o}	99.45	99.62	99.45	99.62
Dextran ppm	525	233	548	252
Starch ppm	385	382	392	385
Ash %gm	0.12	0.02	0.11	0.02
Reducing sugar % gm	0.16	0.09	0.14	0.07
Color IU	675	475	690	490

Table 3 show that the affinationt at temperature 70 ^{o}C, the ratio of dextran decrease by 50%, the quality of affined sugar increase in terms of ash content and reducing sugar

The polarization increased at temperature 70^{o}C about temperature 60 ^{o}C.

Table 4. Affination process at temperature 80^{o}c

Content of sugar	Sample 5		Sample 9	
	Raw sugar	Affined sugar	Raw sugar	Affined sugar
Polarization Z	99.45	99.55	99.45	99.60
Dextran ppm	525	328	548	352
Starch ppm	385	380	392	385
Ash %gm	0.12	0.03	0.11	0.04
Reducing sugar %gm	0.16	0.09	0.14	0.07
Color IU	675	518	690	533

Table 4 show that the affination at temperature 80^{o}C, in this temperature dextran decreased by 27%, it is less than the ratio at temperature 70^{o}C and de colorization is less, the low ratio of ash and reducing sugar is almost close to the different temperature.

Table 5. decolorization % at different temperature.

No of sample	de colorization at T (60) ◦C%	de colorization at(70) ◦ c%	de colorization at T (80) ◦ C%
5	13	30	23
9	13	29	23

Table 5 shows that the following percentage of de colorization at the different temperature of the affination process, the de colorization at 70^{o}C above than at temperature 60, 80^{o}C. From the results obtained that the appropriate temperature for the affination process at temperature 70^{o}C, at temperature 70^{o}C highest de colorization and polarization and lowest dextran content, ash and reducing sugar.

Conclusion

The aim of the present work is to study the effect of temperature on the quality of affined sugar. The results clear that the optimum temperature of affination is 70^{o}C ,at this temperature gives affined sugar is high in polarization, highly decolorizing and has lower dextran, ash and reducing sugar content. At temperature 80^{o}C and 60^{o}C the results are not good with compared temperature 70^{o}C.

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الملخص العربي

جودة السكر المغسول مبدئيا (Affination process) عند دراجات حرارة مختلفة

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تهدف الدراسة تأثير درجة الحرارة علي جودة السكر المغسول في مرحلة الغسيل المبدئي اثناء تكرير السكر وكذلك محتوي السكريات العديدة ومدي تأثيرها على جميع عوامل جودة السكر المغسول مثل (الاستقطاب -اللون -الاملاح – الرطوبة المختزلات). تم اجراء التجارب عند درجات حرارة مختلفة 60 ، 70 ، 80 م^{o} لمرحلة غسيل السكر لمعرفة انسب درجة حرارة في عملية الغسيل وتعطي اعلي جودة للسكر المغسول من حيث الخواص الطبيعية والكيميائية وبالبحث اثبت التجارب ان درجة الحرارة 70 م^{o} هي درجة الحرارة المثلي حيث اعطت أفضل نتائج من حيث (درجة اللون – محتوي السكريات العديدة – مختزلات -املاح) بالسكر المغسول ومن ناحية اخري فان درجة الحرارة 60 ، 80 م^{o} كانت النتائج غير مرضية. بالإضافة الي ذلك اثبت البحث انه يمكن استخدام عملية غسيل السكر في خفض محتويات السكريات العديدة الي 50%.