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RESEARCH ARTICLE

Physicochemical properties and polarization value in raw and refined sugar

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Abstract

This study was evaluating the physico-chemical parameters and polarization value of raw sugar which ultimately affect the filterability of raw sugar. Ten different raw sugar samples were collected from Brazil to the Hawamdia refinery sugar factory. The obtained results revealed that high percentage starch in raw sugar led to low Filterability during dissolve raw Sugar to remove the molasses layer where, its causes problems in refined sugar process and increased cost of production. The ash contents were found to be decreasing for the samples of refined sugar compared to raw sugar. The values for the polarization were the highest in samples of refined sugar while the lowest values were raw sugar samples. It can be concluded that raw sugar samples included low quality whereas samples of refined sugar were determined to be of good grade. Raw sugar contained a high percentage of starch and color it was lower degree of purity, which required necessary to use refining process to produce sugar a higher degree of quality and purity, a low percentage of color and higher purity. Also, refined sugar contained a small percentage of mineral content and polyphenol fraction compared to raw sugar.

Keyword: Raw sugar; Refined sugar; Filterability; Physicochemical parameters; Polarization value

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Introduction

Raw sugar is an intermediate product of the refining and affination process of sugar manufacturing that consists of pale yellow to brown sugar crystals covered with a film of syrup. This is in fact, an intermediate stage in the production of sugar, having sucrose and water contents 95-97% and 0.25-1.1%, respectively. It is of yellowish-brown color due to the presence of molasses (3.6%) and has a burnt flavor with coarse crystal (Javaid et al. 2011). The refining quality of raw sugar (which affects the processing operation and yield in the refinery) is governed not only by the chemical composition of the raw sugar but also by its physical characteristics. A high percentage of ash in the raw sugar is disadvantageous to the refiner because it requires a large char or ion-exchanger capacity to adsorb it. High starch content in raw sugar is also undesirable, because it adversely affects filtration, reduces the capacity of the refinery filter station, and necessitates the use of more filtering, which is not economical. The coloring matter in raw sugar, which is difficult to remove by affination when crystals are conglomerated, causes considerable trouble 6 and expense in a refinery since additional amounts of decolorizing agent will be needed to remove it, and the normal cycle of bone-char, granular carbon or decolorizing ion-exchangers will be shortened, and more frequent regeneration will be required. Therefore, the regularity of raw sugar crystal is very important for the refiner, (Hamadelneel 2013). The process to obtain white sugar from raw sugar is called refining, and it has the objective of removing impurities and colored compounds from the sugar, aiming to achieve a product of as near as possible of 100% purity of sucrose. This process is mainly comprised of a set of unit operations, where the backbone is the clarification and color removal stages, and the specific conditions on which these operations are to be performed depend on the quality and characteristics of the raw sugar to be processed (Rein 2007).

Materials and Methods
Experimental procedures

Accumulating representative samples of raw sugar supplied from Brazil to the Hawamdia refinery sugar factory, Giza, Egypt. Randomized ten samples were collecting from200,000-ton raw sugar and refined sugar during processing and refining season (2021/2022). The samples were collecting to representative 200,000-ton raw sugar and refined sugar. A number of ten samples were collected to study the chemical and physical properties.

Methods
Moisture Content

Moisture was determined by taking 10 g of sample and drying it in a hot air oven at 100˚C + 5˚C for about 3 hours as recommended by A.O.A.C (2012). The loss in weight was the moisture contents calculated by using the following formula:

$$\%\ \text{Moisture content} = \frac{\text{loss of weight during drying}}{\text{Weight of sample}} \times 100$$

Ash Content

Total ash contents were determined as described in A.O.A.C (2012) by taking 5-gram sample in the china dish and placed on low flame while the mass is thoroughly charred, then the sample was heated in muffle furnace at 500˚C + 50˚C until white ash was obtained. This ash was cooled in the desiccator and weighed in percentage using the following formula:

$$\%\ \text{Total ash} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Color Analysis

Color was determined measuring Spectrophotometer (Jenway 7310) at 420 nm as ICUMSA units according to (ICUMSA 2017).

$$\text{Color (ICUMSA)} = \frac{\text{milli absorbance unit (MAU)}}{\{\text{Cell length (mm)} \times \text{conc. of total solids (g/ml)}\}}$$

$$\text{Color (ICUMSA)}_{420\ nm} = \frac{A \times 106}{b \times RDS \times d}$$

Where: A is absorbance, b is cell path length (sample tube diameter) in mm, and d is the density {calculated from RDS-density regression

Equation = (0.0055 × RDS + 0.9714)}. (RDS (refractometer dry substance).

Analytical method polarization, reducing sugars was determined according to users of this Lane and Eynon, Starch content determines according to (ICUMSA 2017). Safety factor which are related to the moisture content of raw sugar, serve as quality criteria for raw sugar storage). The safety factor found by (Whalley 1954) using the following equation:

$$\text{Saftey factor} = \frac{\text{moisture}(\%)}{100 - \text{polarization}}$$

Filterability determination

The filterability determination was carried out by standardized lab filtration, uses solution from raw sugar at Brix 65, and used filter paper (stander filter paper size 200mm), it is done at temperature 60oC.Samples solution of raw sugar was prepared at 65.0 Brix, and pH 6.5 (natural), the solution was Stoppard and heated in a water bath to temperature 60_o C, transferred the solution to funnel having the filter paper, and used stopwatch was simultaneously started. The filtrate volume for each sample was collected after 10 minutes, to calculate the filterability of each raw sugar samples is using the formula (Suleiman and Musa 2017).

$$\%\ \textbf{Filterability} = \frac{\textbf{Vol. of filtrate of the test solution}}{\textbf{Vol. of filtrate of the pure refined sugar solution}} \times \textbf{100}$$

Determination of mineral content

The minerals content of raw and refined sugar were determined according to the method described by A.O.A.C. (2012), using atomic absorption device (Perkin – Elmer, Model 3300, USA) in Analytical chemistry unit, Department of chemistry, faculty of science, Assiut university.

GC-MS analysis of polyphenol

The polyphenol compounds were absorbed onto extraction of sample Sugar samples (1 g) were soluble in 2 mL chloroform and centrifugation at 10000 rpm at 20 °C for 15 min. Apparatus: GC-MS (7890-5975), carrier gas is Helium, column DB-5ms (30m). The GC-MS analysis was carried out on an GC-MS (7890-5975) system with a column DB- (30 m × 0.25mm × 0.25 µm,). The GC injector was both set to 280 °C. The oven temperature program was started at 40 °C, increased at the rate of 2 °C/min to 280 °C, and then at a rate of 10 °C/min to 150 °C, with a 10-min isothermal period at 220 °C. MS readings) were taken at 0.5 s scan intervals. This analysis was worked in Analytical chemistry unit, Department of chemistry, faculty of science, Assiut university.

Statistical analysis

The statistical analysis of the obtained data was performed by analysis of variance (ANOVA) and the results were submitted to Duncan's test according to the program SAS (SAS 1999).

Result and Discussion

Polarization value, moisture and ash content on raw and refined sugar samples

Data tabulated in Table (1) showed that polarization, moisture content and ash content of raw and refined sugar samples. The data in table (1) revealed that the values for polarization % of raw sugar were affected significantly by the samples, while was affected non-significantly in refined sugar. The mean values of polarization % for the samples of raw sugar were ranging from of 99.12- 99.32 %. While refined sugar was highest polarization value compared with raw sugar, The mean values of polarization % for the samples of refined sugar were ranging from 99.82- 99.88 %.

The results are in a good agreement with (Suleiman and Musa 2017; Eggleston 2018). The decreasing in the value of polarization was might due to the fluctuation in the processing of raw sugar and also the coloring compounds and the impurities may have an interaction in the determination of this parameter. while for the values that are highest for some samples might be due to the more sucrose contents because raw sugar still needs further processing in order to make it palatable for human consumption (Chen and Chou 1993; Ali et al. 2001; Rasool 2015). The higher polarization of raw sugar mean lowers the impurity load on the refinery, and the higher the refined sugar output or yield per ton (Arias 1993).

The values for moisture contents of raw and refined sugar were affected significantly by the samples. The moisture contents of the different samples were highest in raw sugar compared with refined sugar, were ranging from 0.100 - 0.200, 0.030 - 0.053%; respectively. The results are in a good agreement with (Eggleston 2018; Suleiman and Musa 2017; Azlan et al. 2020).

The moisture content of the sugar is adaptable because of the non - reducing sugars during the process of manufacturing. The moisture of raw sugar is probably the most important parameter determining its stability and keeping quality during storage (Ergun et al. 2010). Destruction of sugar by osmophilic yeasts could take place in the syrup film surrounding the crystal providing conditions that are appropriate and sufficiently diluted (Waston and Wilson 1975). The relation shape between moisture and non-sucrose in raw sugar expressed in terms of “the safety factor”.

Ash values of raw and refined sugar samples as shown in table (1) the mean values were affected non-significantly for ash content in different sugar samples. The ash contents of the different samples were highest in raw sugar compared with refined sugar, were ranging from 0.110 - 0.120, 0.011 - 0.018 %; respectively. such results are in accordance with those recorded by (Rein 2009; Javaid et al. 2011; Rasool 2015; Azlan et al. 2020). Ash effect on the refinery process as if the chlorides accumulation in lower grade syrup cane cause corrosion cracking of centrifugal (Figeada 2017), there is high sulfate in affinated sugar produced scaling in pan and evaporator which effect on heat transfer.(Chou 1989) illustrates if the sulfite ash level of 200mg/kg in raw sugar can reduce the efficiency of ban char decolorization, also if the level of sodium and potassium more than calcium and magnesium the yield of refinery sugar will be affected.

Table 1. Polarization value, moisture and ash content on raw and refined sugar samples.

Sample	Polarization(°Z)		Moisture%		Ash% gm	
	Raw sugar	Refined sugar	Raw sugar	Refined sugar	Raw sugar	Refined sugar
1	99.13^{f} ± 0.03	99.86^{a} ± 0.05	0.186^{ab} ± 0.05	0.040^{ab} ± 0.01	0.113^{a} ± 0.01	0.016^{a} ± 0.01
2	99.12^{f} ± 0.02	99.88^{a} ± 0.02	0.200^{a} ± 0.02	0.030^{b} ± 0.01	0.110^{a} ± 0.00	0.011^{a} ± 0.00
3	99.13^{f} ± 0.03	99.86^{a} ± 0.05	0.153^{bc} ±0.02	0.046^{ab} ±0.02	0.113^{a} ± 0.01	0.016^{a} ± 0.00
4	99.18^{e}± 0.01	99.85^{a} ± 0.01	0.120^{cd} ± 0.02	0.040^{ab} ± 0.01	0.110^{a} ± 0.01	0.018^{a} ± 0.00
5	99.23^{d} ± 0.03	99.84^{a} ± 0.01	0.120^{cd} ± 0.02	0.033^{ab} ± 0.02	0.110^{a} ± 0.02	0.012^{a} ± 0.00
6	99.23^{d} ± 0.03	99.86^{a} ± 0.03	0.126^{cd} ± 0.01	0.040^{ab}± 0.01	0.110^{a} ± 0.01	0.015^{a} ± 0.00
7	99.25^{cd} ± 0.01	99.84^{a} ± 0.03	0.110^{cd} ± 0.01	0.050^{ab} ± 0.01	0.110^{a} ± 0.01	0.017^{a} ± 0.00
8	99.27^{bc} ± 0.02	99.85^{a} ± 0.03	0.100^{d} ± 0.01	0.043^{ab}± 0.01	0.110^{a} ± 0.00	0.014^{a} ± 0.00
9	99.30^{ab}± 0.02	99.82^{a} ± 0.02	0.120^{cd} ± 0.03	0.053^{ab} ± 0.01	0.120^{a} ± 0.01	0.016^{a} ± 0.00
10	99.32^{a} ± 0.02	99.85^{a} ± 0.05	0.140^{cd} ± 0.02	0.053^{a} ± 0.01	0.116^{a} ± 0.02	0.016^{a} ± 0.00

Values are mean ±standard deviations.

Data in Table 2 showed that reducing sugar, reducing sugar /ash ratio and safety factor of raw and refined sugar samples. The data in Table 2 revealed that the mean values for reducing sugars% was affected significantly in raw sugar, while were affected non-significantly in refined sugar. The reducing sugars% of the different samples was highest in raw sugar compared with refined sugar, were ranging from of 0.180-0.220, 0.023-0.051%; respectively. The results are in a good agreement with (Eggleston 2018.; Javaid et al. 2011; Rasool 2015). Reducing sugar mixture of approximately equal parts of glucose and fructose, monosaccharide resulting from the hydrolysis of sucrose, in raw sugar the reducing sugar most less than 0.8 g /100g, the ratio of reducing sugar to ash raw and refined sugar was ranging from 1.55-2.00, 1.43-4.63, respectively. The safety factor was raw and refined sugar ranging from 0.13-0.22, 0.20-0.35, respectively. The reason for the high level of reducing sugar leads to the loss of sucrose into molasses, the effect of the inverted sugar on recovery operation is divided into two parts, one to increase the losses sucrose in molasses, and the other to decrease the sucrose in molasses, the two parts also use the ratio of reducing sugar to non-sugar (q Rs /Ns) or called Tate and Lyel “g " factor (Donovan 1993).

Table 2. Reducing sugar content and safety factor on raw and refined sugar samples

Sample	Reducing sugar% g		Reducing sugar/Ash ratio		Safety factor	
	Raw sugar	Refined sugar	Raw sugar	Refined sugar	Raw sugar	Refined sugar
1	0.220^{a}± 0.00	0.033^{bc}± 0.03	1.94^{ab}± 0.10	2.06^{abc}± 2.7	0.21^{ab}± 0.05	0.28^{cd}± 0.11
2	0.220^{a}± 0.02	0.051^{a}± 0.00	2.00^{a}± 0.18	4.63^{a} ± 0.7	0.22^{a}± 0.02	0.25^{cd}± 0.06
3	0.220^{a}± 0.04	0.050^{a}± 0.00	1.94^{ab}± 0.27	3.12^{abc}± 0.6	0.17^{bcd}± 0.02	0.32^{ab}± 0.15
4	0.206^{ab}± 0.02	0.032^{bc}± 0.00	1.87^{ab}± 0.27	1.77^{bc} ± 0.2	0.14^{d}± 0.02	0.26^{cd}± 0.07
5	0.203^{ab}± 0.01	0.042^{ab}± 0.00	1.84^{ab}± 0.30	3.50^{ab} ± 0.1	0.15^{d}± 0.03	0.20^{d}± 0.11
6	0.200^{ab}± 0.01	0.043^{ab}± 0.00	1.81^{ab}± 0.23	2.86^{abc}± 0.9	0.16^{d}± 0.01	0.28^{bc}± 0.11
7	0.203^{ab}± 0.02	0.042^{ab}± 0.00	1.84^{ab}± 0.27	2.47^{abc}± 0.9	0.14^{d}± 0.01	0.31^{abc}± 0.02
8	0.186^{b}± 0.01	0.024^{c}± 0.00	1.69^{ab}± 0.10	1.71^{bc} ± 0.5	0.13^{d}± 0.02	0.28^{bc}± 0.11
9	0.196^{ab}± 0.01	0.023^{c}± 0.00	1.63^{ab}± 0.15	1.43^{c} ± 0.5	0.17^{bcd}± 0.03	0.29^{cd}± 0.13
10	0.180^{b}± 0.01	0.023^{c}± 0.00	1.55^{b}± 0.16	1.43^{c} ± 0.5	0.20^{abc}± 0.03	0.35^{a}± 0.08

Values are mean ±standard deviations.

Data in Table 3 showed that the color content and starch content of raw and refined sugar samples and was showed filterability in raw sugar. The mean values for the color contents in different raw and refined sugar samples were affected high significantly for the samples, raw sugar was higher color than refined sugar, and ranging from 639-912, 52-66 ICUMSA units, respectively. This might be due to the impurities and interaction in the determination of this parameter. The color in raw sugar plays an important role in high-quality sugar these results are similar to those obtained by Suleiman and Musa (2017) and Rein (2009).Sugar crystals are covered with molasses having a brown golden in color. Another way that sugar quality is measured is through "color". The term color refers to a wide range of complex and molecular components that contribute to the overall appearance of sugar. The color is dependent on the residual molasses that are not removed in the refining process (Javaid et al. 2011). The color in raw sugar plays an important role in sugar refinery (Chou 1989), also the color is one of the important parameters of raw sugar (Clarke et al. 1993) 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. In the storage of the raw sugar, the quality changed because of an increase in color, the increase not only in the molasses film but also inside the crystal (Chen 1969).In another hand, the data in Table 3 revealed that the values for starch content in different raw and refined sugar samples were affected high significantly for the samples, raw sugar was higher in starch content than refined sugar, and ranging from 293-361 ppm in raw sugar, while in the refined sugar ranged from 49-70 ppm. Such result is in accordance with those recorded by (Suleiman and Musa 2017; Sastre et al. 2020). Starch is one of polysaccharides that are the subject of our study; the samples contain high starch content, starch occurs naturally in cane as smell granules, it is formed by condensation of glucose, and consist of two types of polysaccharides, the highest percentage amylopectin represents75-85%in the starch and high branched structure (Alves et al. 2014).

It can be easily removed by filtering when the largest granules are readily gelatinized and increase viscosity. About 30% of the starch in juice eventually appears in raw sugar crystals. In the carbonation refining process, it interferes with the precipitation and coagulation of calcium carbonate crystals. This results in poor filterability after clarification (Murray 1972). It is generally accepted that starch levels exceeding 250 ppm of raw sugar cause refinery problems. In these samples from the sugar-refining factory in Hawamdia, Egypt, starch analyzes are higher than 250 ppm, which leads to a problem in refining processes. Table 3 showed that filterability for ten samples in raw sugar, filterability percentage sample (1) is low starch content and high filterability, it was sample (10) is high starch content and low filterability, from the results recognized that samples have high starch content gave poor filterability. The presence of fine insoluble material has an adverse effect on filterability in the refinery (Donovan 1993). Also, in phosphatation refining starch effect adversely on precipitation and coagulation of calcium phosphate in carbonation, the amylose act as a protective colloid, coating the surface of the growing calcium carbonate crystal this causes agglomeration of calcium carbonate this result causes poor filterability (Murray et al. 1976), generally the starch level exceeding 250mg/kg cause refinery problems (Donovan 1993). Filtration is a relatively old and well-established unit operation in which suspended particles are removed or concentrated from a particle, fluid mixture this is achieved by moving the mixture to a porous medium which stops the particles but allows the fluid to pass through (Chou 2000). Polysaccharides in raw sugar can have a major effect on filterability; the most important of those is starch (Beter 2017). The different filtering qualities of raw sugar were early recognized as having economic importance, and the investigation of the cause of variations in filtration rates of raw sugar made by much research (Vane 1981). This is exacerbated by the lack of a uniform or standardized method for measuring α-amylase activity in the sugar industry or a regulatory body to issue or regulate standard methods and units of activity for the commercial enzyme. Efficiency from the action of α-amylase to analyze starch in the syrup is bound to the used Alpha-amylase activity (Eggleston et al. 2017). The availability of sugarcane varieties with low starch content should provide a more sustainable and long-lasting solution (Eggleston et al. 2006). To reduce the starch use of α-amylase to analyze starch during processing, α-Amylases (endo-1 → 4-α-D-glucagluco hydrolases. But α-Amylases are expensive and not always effective. α -Amylase is usually added to Before the last or last evaporator Body because the starch is in a completely dissolved and gelatinous form which is more suitable for α-amylase hydrolysis (Tester et al. 2004).

Table 3. Relationship between color, starch, and filterability on raw and refined sugar samples.

Sample	Color (IU)		Starch (ppm)		Filterability ml / 10min
	Raw sugar	Refined sugar	Raw sugar	Refined sugar	Raw sugar
1	912[a] ± 2	52[c] ± 1	293[g] ± 1	59[cd] ± 1	35[a] ± 1
2	700[d] ± 5	56[abc] ± 4	298[f] ± 1	61[bcd] ± 4	32[ab] ± 4
3	689[e] ± 5	60[abc]± 6	304[e]± 4	61[cd] ± 1	29[bc] ± 4
4	639[h] ± 5	54[bc] ± 5	320[d] ± 5	61[bcd] ± 2	27[bcd] ± 2
5	780[c] ± 5	54[bc] ± 7	332[c] ± 2	62[bc] ± 3	25[cd] ± 5
6	900[b] ± 10	57[abc] ± 6	345[b] ± 5	66[ab] ± 5	24[cd] ± 2
7	694[de] ± 4	60[abc] ± 8	341[b] ± 1	70[a] ± 1	24[cd] ± 4
8	663[g] ± 3	62[ab] ± 3	342[b] ± 2	63[bc] ± 1	23[d] ± 3
9	656[g] ± 7	66[a] ± 5	341[b] ± 1	57[d] ± 2	24[cd] ± 1
10	673[f] ± 3	64[a] ± 1	361[a]± 2	49[e] ± 3	22[d] ± 2

Values are mean ±standard deviations.

Data presented in Table 4 shows the mineral contents of the tested raw and refined sugars samples. The assay results revealed the presence of various essential elements, including elements like phosphorus, magnesium, calcium, potassium, sodium, iron, in raw and refined sugar. The results showed that magnesium is the highest element in raw and refined sugar was 622.84-120.73 mg/kg, while the less element was iron (3.18-1.19 mg/kg). The mineral contents of the different samples were highest in raw sugar compared with refined sugar. Jaffe´ (2015) reported that the minerals in non-centrifugal sugars, including essential minerals such as Ca, chlorides and K (in order of 100 mg/100 g), followed by P, Na and Mg (in order of 10 mg/100 g), Cu and Fe (in order of 1 mg/100 g), Mn and Zn (in order of 0.1 mg/ 100 g) and Cr and Co (in order of 0.01–0.001 mg/100 g). The mineral content in samples of refined sugar, crystal sugar, and conventional brown sugar from refined sugar were presented in the previously mentioned study, which confirmed the loss of mineral nutrients in white sugars (refined and crystal). Conventional brown sugar from refined sugar, remained with a reasonable amount of most essential minerals, with emphasis on Ca, Mg and K (Sampaio et al. 2020). The mineral contents could be correlated with the ash values, which indicated that the unrefined sugars exhibiting the highest ash contents also had the highest total mineral contents. Similar findings have been reported previously in investigations of both refined and unrefined sugars (Rodríguez et al. 2004; Shaheen and Mannan 2013; Singh et al. 2013). In general, sugarcane juice has a high concentration of potassium. Therefore, unsurprisingly, potassium was detected at high levels in the tested sugars. The variation among the minerals is likely a result of the variation in their levels in sugarcane juice, which is affected by different agroecological factors and processing techniques (Guerra and Mujica 2010).

Table 4. Mineral composition of raw and refined sugar.

Mineral (mg/kg)	Sample	
	Raw sugar	Refined sugar
Phosphorus (P)	16.07	16.05
Magnesium (Mg)	622.84	120.73
Calcium (Ca)	68.67	27.45
Potassium (k)	173.39	15.78
Sodium (Na)	70.01	76.30
Iron (Fe)	3.18	1.19

Data tabulated in Table 5 shows polyphenol fraction in raw and refined sugars samples, the predominant compound was identified as Verbascoside A - Hydrolyzed Cpd, with a peak area of 2.159% in raw sugar, while was 0.007% in refined sugar. However, most of the compounds present in the sugar samples were present in quantities ranging from 0.010 to 2.159%. The rest of the identified compounds were present in minor quantities and included aldehydes, pyrazines, pyranoses, phenolic, nitrogen-containing compounds, carboxylic acids, terpenes, alkenes, bicyclic alcohols, and cyclic and bicyclic ketones. Several previous reports have revealed the presence of similar compounds in no refined sugars, which supports the present findings (Asikin et al. 2014; Asikin et al. 2016; Jaffé 2015). While 2-acetylpyrrole occurs naturally, it can also be produced by the Millard reaction, particularly by the reaction of glucose and fructose with lysine, glycine, or alanine (Asikin et al. 2016). In general, a possible reason for the existence of Millard reaction products such as pyrazines, furans, and pyranoses in sugars could be the application of high temperatures treatment of sugarcane juice (Osada and Shibamoto 2006). Additionally, the presence of bis (methyl sulfonyl) methane and dimethyl sulfoxide in the tested sugar samples indicated a high-temperature treatment of sugarcane juice (Xu et al. 2014).Millard reaction products are responsible for the pigmentation, fragrance, and flavor of sugar products (Payet et al. 2005; Wong et al. 2008). Alcohols, pyrazine, and ketones play an important role in the aroma and color profiles of sugars. Especially, the presence of 2,3-dihydro-3,5-dihydroxy-6-methyl-4Hpyran-4-one and 5-methyl-2- furan methanol can produce peculiarly sweet, cotton candy/maple-like, minty, herbaceous, and/or caramel-like odors in unrefined sugars (Asikin et al. 2014; Payet et al. 2005). Furthermore, pyrazine compounds such as 2,3-, 2,5-, and 2,6-dimethylpyrazine, and 2,3,5-trimethylpyrazine in unrefined sugars imbu sugars with nutty, roasted, and coffee-like fragrances (Asikin et al. 2014; Jousse et al. 2002).

Table 5. Polyphenol fraction on raw and refined sugar by GC-mass.

Parameter	Sample	
	Raw sugar (%)	Refined sugar (%)
(3R)-3-Methyl-3-(6-O-caffeoyl-. beta., D-glucopyranosyloxy) pentan-5-olide pentaace	0.028	ND
2-(2-Aminopropyl) phenol #	0.095	0.019
3-(2-BENZIMIDAZOLYL)-6,8-DIBROMO-4-HYDROXY-2(1H)-QUINOLINONE	0.042	ND
3-Methyl-2-(2-azidoethyl)-3H-quinazolin-4-one	0.116	ND
4-Hydroxy-3-(2-oxo-2h-1-oxa-3-phenanthryl)-2(1h)-quinolinone	0.134	ND
5-(2-Aminopropyl)-2-methylphenol	0.081	ND
sopropylidene-Azastreptonigrin	0.011	ND
Bactobolin	0.018	ND
Benzaldehyde, 3,5-dichloro-2-hydroxy-, 2,2-dimethylhydrazone	0.021	ND
Bisphenol A diglycidyl ether	0.013	ND
Diethyl 2-[(p-acetoaminophenyl) sulfonyl) aminopyrrolo[2,1-a] isoquinoline-1,3-dica	0.036	ND
Glaucenine	0.048	0.010
2,2'-[(1-Methyl-1,2-ethanediyl) bis(nitrilomethylidyne)] bis-Phenol,	0.062	ND
4-[2-(methylamino)ethyl]-Phenol	0.028	ND
4-(2-Amino-1-hydroxypropyl) phenol #	0.034	ND
Verbascoside A - Hydrolyzed Cpd.	2.159	0.007
Hydroxy[(1-oxo-2-propenyl) amino]-Acetic acid	ND	0.094
campestanyl 4"-acetylferulate	ND	0.014
2,4-Bis(1,1-dimethylethyl)-Phenol.	ND	0.010

ND (not detected).

Conclusions

From the obtained data in this study, it can be concluded that the sample refined sugar is the best regarding the sugar quality, it became shows that the refining process is very important for the production of white sugar suitable for direct consumption and also important for many food industries. The obtained results show that refined sugar is of higher quality than raw sugar used in the industry.

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