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EVALUATION THE QUALITY PARAMETERS OF SUGAR CANE AND RAW SUGAR SAMPLES AT SEASON 2017 WITH REFERENCE TO (SASTA, 2009) AND (ICUMSA, 1994) STANDARDS

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ABSTRACT: *The study was conducted in Sudanese Sugar Industries during period at 2017 to aims Evaluation the Quality parameters of sugar cane and raw sugar samples with reference to (SASTA, 2009) and (ICUMSA,1994) standards. The samples were obtained from all Sudanese Sugar Industries namely, (Kenana, White Nile, Assalaya , Sennar, Guneid and New Halfa).After that the samples were transferred to the laboratory to assessment the quality parameters of sugar cane which include Weight Kg per ten stalks, length Kg per ten stalks, and nods of cane Kg per ten stalks, Fiber percent of cane%, Moisture content of cane%, Brix of cane (Total dissolved Solids%), Polarization (Pol.) of cane%, Purity of cane%, Reducing sugars of cane juice % and pH of cane. and quality parameters for raw sugar which include Determination of Physiochemical parameters of raw Sugar samples collected from Sudanese Sugar Industries at season 2017: which include colour, Mean Apparatus (M.A), Coefficient of Variation (C.V %), Dust %, Pol %, Purity %, Moisture % and Ash %. and the data were analyzed by using Statistical system complete randomized design (CRD) and analysis of variance technique by Lest Significant Different Test (LSD) according to Fisher's LSD method, 2010 at Probability 0.05 Was applied to compare differences between industries. The results It was concluded that the some quality parameter of cane like Brix%, Pol%, Purity%, and Fiber % were satisfactory with quality standard in all Sudanese Sugar Industry, While the moisture % was higher than recommended range in all Industries. It was concluded that the quality parameter of raw Sugar like Moisture % all Industries online with standard except Industries Kenana and Guneid. In case of Ash% all Industries were online with standard. In case of Colour Industries Assalaya and Sennar were lower while the Industries Guneid and New Halfa were higher than satisfactory range. In case of C.V% all Industries were higher than recommended limit. In case of Dust Industries Kenana and White Nile were higher than critical maximum value respectively. In case of Pol% only Assalaya and Sennar was within optional perimeter. In case of Purity% for sugar A the Industries White Nile and Guneid were lower than recommended range. The study recommendations that the Sudanese Sugar Industry needs to establish proper quality assurance laboratories to help in monitoring quality and safety of raw materials and end productions.*

KEY WORDS: evaluation, quality parameters of sugar cane and raw sugar, sudanese sugar industry with reference to (SASTA, 2009) and (ICUMSA, 1994) standards

INTRODUCTION

Raw sugar is an intermediate product of refining and affixation 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 burnt flavor with coarse crystal (Javaid *et al.*,2011).The sugarcane (Saccharum officinarum L.) is a commonly distributed plant and is one of the most significant sources of sugar in Sudan. Current reports have shed light on numerous biological properties of sugarcane and its resulting products. Fresh sugarcane juice is widespread in Sudan as an inexpensive and sweet beverage. It is becoming a fashion juice and thirst satisfying drink served at roadside stalls, canteens and cafeterias throughout the country during the harvest season (Ali *et al*, 2001). Sugarcane is grown in rain season and is one of the main cash crops of Sudan. It delivers raw material to sugar industries and sugar associated products. For the rural community of the country, it produces income and services. Vital items for industries like sugar, chipboard and paper, sugarcane help in their value addition. Its share is 3.6 percent in agriculture and 0.8 percent in GDP. For the year 2009-10, an area of 943 thousand hectares is under sugarcane cultivation which is 8.4 percent less as compared to the previous year (1029 thousand hectares). Production of the sugarcane for the year 2009-10 is assessed to be 49.4 million tons, in contrast to 50 million tons previous year; ultimately the production is reduced to 1.3 percent. Key factors involved for low productions were canal water scarcity, electricity shortage; area under wheat crop during 2008-09 was maximum ultimately confining the sugarcane acreage. Lower prices for the sugarcane crop in the previous year and higher inputs rates also restricted the farming community from growing sugarcane crop GOP (2009-2010).The keeping quality of sugar was studied keeping in the view that the process of drying played a pivotal role. By keeping the sugar under humid conditions, microbial decomposition along with loss of sugar occurred rendering the quality of sugar impure. After the process of drying, the process of polarization becomes augmented and the notorious effects of microorganisms become less. If the sugar is wet when fed into the dryer, a large amount of heat is required for the process of drying the sugar. If the size of the crystals of sugar becomes enlarged, it will ultimately increase the moisture percentage of the sugar sample (Javaid *et al.*,2011).

The main aim of this study is to analyze raw sugars, for evaluation the Quality parameter. The specific objectives are to determination of Physical and chemical parameters of sugar cane and raw sugars samples were collected from from Sudanese Sugar Industries at season 2017. After that compare with Quality parameter is established by (SASTA, 2009) and (ICUMSA, 1994,) standards.

General objective:
Determination of Physiochemical parameters of sugar cane and raw Sugar samples were collected from Sudanese Sugar Industries at season 2017 in relation to (SASTA, 2009) and (ICUMSA,1994) standards.

Specific objectives:
► Determination of Physiochemical parameters of sugar cane samples collected from Sudanese Sugar Industries at season 2017: which include Weight Kg per ten stalks, length Kg per ten stalks, and nods of cane Kg per ten stalks, Fiber percent of cane%, Moisture content of cane%, Brix of cane (Total dissolved Solids%), Polarization (Pol.) of cane%, Purity of cane%, Reducing sugars of cane juice % and pH of cane.

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► Determination of Physiochemical parameters of raw Sugar samples collected from Sudanese Sugar Industries at season 2017: which include colour, Mean Apparatus (M.A), Coefficient of Variation (C.V %), Dust %, Pol %, Purity %, Moisture % and Ash %.

MATERIALS AND METHODS

Table 1.2 Daily capacity and annual production (ton/year) of sugar by main Sudanese sugar factories

Sugar factory	Daily capacity(tons of cane crushed/ day)	Annual production (ton of sugar/year)
Guneid	(4000)	60000
New Halfa	(5000)	75000
Assalaya	6500	110000
Sennar	6500	110000
Kenana	17000	400000
White Nile	24000	450000

(El hajwa, 2000).

Sampling

Samples of sugarcane were obtained from the field of the sugar Industries. Samples were kept in polyethylene page (PEP) and labeled; sugar samples were kept in dry bottles, sealed tightly and labeled. All samples were then transferred to the analytical laboratory for assessment the physiochemical properties with reference to standards SASTA, 2009 And ICUMSA, 1994.

Methods of analysis

All physiochemical analysis of sugar cane and juice was carried out according to South African Sugar Technologists Association (SASTA, 2009) whereas the physiochemical analysis of raw sugar was carried out according to the International Commission for Uniform Methods of Sugar Analysis (ICUMSA, 1974, 1978).

Assessment the quality parameters of sugar cane samples collected from Sudanese Sugar Industries at season 2017:

Weight, length, and nods of cane

Three bonds, each containing 12 stalks, were collected from each factory's field. For determination of cane weight, ten stalks canes were weighed in a 5 Kg. Balance, and the weight was recorded. For determination of length**,** all stake canes were measured by meter tape and length expressed as means. Nods of cane were counted by hand, recorded and expressed as means.

Fiber percent of cane

Canes were cut into small slices by special machine; 110 grams were taken by sensitive balance in pocket smoke cotton and recorded as weight (W1). The sample was treated with running tap water for 3 hours to clean all sugar present in sliced cane; formaldehyde indicator was added to insure complete absence of sugar. Sliced cane was then pressed to remove excessive water, placed in oven

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for three hours at 105 c., removed from the oven after drying, and re-weighed (W2). Percent fibrous material in cane was calculated using following equation;

$$\%\text{Fiber in cane} = \frac{\text{weight of sliced cane after drying}}{\text{weight of sliced cane before drying}} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots 1$$

Moisture content of cane

A clean dried moisture tray was weighed and weight was recorded as empty tray weight (M1). Whole stalk cane was cut into billets approximately 70 mm in length, passed through the cutter grinder, and some placed on the tray. The tray with the cane bagasse mass was weighed and the weight was taken as (M2). The tray with the cane bagasse mass was then kept in the oven at 105c for 60 minutes to dry out.

After drying, the tray plus the dry material were cooled avoiding absorption of moisture, and then re-weighed and latter weight was recorded as (M3). Level of water in cane was calculated from the following equation;

$$\%\text{Moisture(water)in cane} = \frac{M2 - M3}{M2 - M1} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where;

M1 = Weight of empty tray

M2 = Weight of empty tray plus fresh cane sample

M3 = Weight of empty tray plus dried cane sample

Brix of cane (Total dissolved Solids)

Sample was mixed well, hydrometer jars filled to overflowing near room temperature, allowed to stand for at least 20 minutes, brix hydrometer was inserted, spindle was carefully re-inserted to keep the stem dry above the liquid, and all readings were taken with the juice overflowing from the cylinder. The temperature was taken at the time of reading, and the temperature correction to reading of Brix table. The standard correction of the hydrometer was also applied to every reading"Uncorrected"

$$\text{The Actual Brix} = \text{Hydrometer reading} + \text{Temperature correction} \ldots\ldots 3$$

Polarization (Pol.) of cane

A150 ml of juice was placed in a flask, 2 spatula of lead acetate and 1 spatula of Kieselguhr were added to clarify solution, and then volume completed with water to the mark. A 20ml was taken into a 200 mm tube which was placed in the Polarimeter apparatus for reading. The actual polarization (Pol.) was obtained from Schmitz's Table 3for Pol. Whenever the Pol. Reading had decimal point, the supplementary Table of Schmitz's Table was used.

Purity of cane

Percent apparent purity in cane was obtained from Pol & Brix determined earlier in the composite sample;

$$\text{Purity in cane } \% = \frac{\mathbf{Pol}}{\mathbf{Brix}} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

Reducing sugars of cane juice

A150 ml of juice was placed in a flask, 1.5 spatula lead acetate (approximately 8 grams) added for clarify of solution and the volume completed to 150 ml with water. The value of Juice brix

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(percentage of sucrose by weight) was used to obtain the apparent density of juice at 20 ^{0}C in table density.

pH of cane

About 150 ml of juice was placed in a flask, the electrode of the PH meter was inserted into the juice, and reading was recorded directly.

Assessment the quality parameters of raw sugar samples were collected from Sudanese Sugar Industries at season 2017

Determination Color of raw Sugar:

Place of taking sampling: after separation machine and before melted

Procedure:

1- Accurately 5 grams of raw sugar by used sensitive balance in conical flask 100 capacity

2- The sugar was melting completely using distilled water and the volume made up line 100 ml

3- Then before filtration step multiples drops were put in conductivity meter apparatus for takeout the ash reading directly

4- Also the Brix was reading for the same sample by refractometer and the factor of Brix removed from table Brix factor.

5- After that the sample filtrated as well as part of these filtration was transferred by talameter tubes to talameter apparatus intended for colour reading

$$\text{Colour of raw Sugar} = \text{Brix factor} \times \text{talameter Reading} \dots\dots\dots\dots\dots\dots 5$$

Determination of Dust, Mean Apparatus (M.A) and Coefficient of Variation (C.V) in raw sugar samples collected from Sudanese Sugar Industries at season, 2017:

Hundred grams sugar were weighed and placed on a shaker of 6 sieves with different mesh sizes, the shaker was operated for 10 minutes, and the fractions were then collected, weighed separately to get amount of sugar for each sieve. Dust of sugar was obtained from the equation;

Dust of sugar = 100 – the amount of sugar distributed for each sieves except sieves number 6

The dust of sugar was determined by the equation:

Dust of sugar = weight of sieve (6) with dust - weight of sieve (6) empty…….6

For determination the Mean Apparatus and Coefficient of Variation were calculation by flow charge:

M.A = the cross line 50 represented reading of M.A …….....7

$$C.V = \frac{cross\ line\ 50 - cross\ line\ 84}{cross\ line\ 50} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 8$$

Determination the chemical parameters of raw Sugar samples collected from Sudanese Sugar Industries at season 2017:

Determination Pol of Raw Sugar:

Polarization and moisture are determined as often as desired.

In the weekly composite sample, the following determinations are made.

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Polarization or Sucrose:
The normal weight (26.00 grams) is weighed out,' transferred to an accurately calibrated 100 ml flask and dissolved in about 70 ml. of water.
If hot water .has, been used for this purpose, cool to room temperature, clarify and make up to the 100 ml. mark with water.
For white sugar, .use 2 drops of basic lead acetate solution and 1/2 ml of alumina cream for clarifying.
For raw sugar clarify with about 2 ml. of basic lead' acetate solution, varying the quantity with the grade of sugar.
For low grade sugar, about 5 mls of basic lead acetate solution will be necessary. The solution should be well shaken and filtered in a covered vessel to prevent evaporation. Polarize in a 200 mm, tube. The reading gives - direct the polarization or sucrose content.

Determination Purity (%) of Raw Sugar:
Determination Moisture content of raw Sugar:
Ten grams of sugar are accurately weighed in a small dish or watch glass, and dried to constant weight in an oven at a temperature not exceeding 105°C.
Weight lost X 10 = Moisture per cent sugar……9
Determination Ash content of raw Sugar:
The ash was determination by the flowing equation;

$$ASH = (sample\ reading - \ water\ reading \ \times \ 0.9) \times \ 0.0018 \ldots\ldots\ldots\ldots 10$$

Statistical Analysis:
The quantitative collected data was entered and analyzed by using Statistical system complete randomized design (CRD) and analysis of variance technique by Lest Significant Different Test (LSD) according to Fisher's LSD method, 2010 at Probability 0.05 (equivalent to a 95% confidence level), Was applied to compare differences between industries**.**

RESULTS AND DISCUSSION

The physical properties of Sugar Cane samples collected from the Sudanese Sugar Industries at season 2017:

Determination the physical properties of Sugar Cane samples collected from the Sudanese Sugar Industries at season 2017:

Cane weight: cane weight is the product of its length, girth and contributes substantially towards final cane yield.
In Table 4.1 it was shown that the highest weight were 0.82 kg and 0.78 kg/ten canes and recorded by Kenana and Assalaya while the lowest 0.68 kg / ten canes and recorded by Guneid and New Halfa. These result lower than 1.38 was recorded by Shanmuganathan *et al*, 2015. As well as lower than standard level (1.58 kg). The analysis of variances revealed there is no significant difference between Kenana and Assalaya and between factory Sennar, Guneid and New Halfa respectively at level of significant 0.05%.

Cane length: Height of cane contributes materially towards final cane yield.

The highest length was 233.33 and 220.67 cm/ ten canes and they are recorded by Kenana and Assalaya respectively where the difference was not significant at 0.05, these result best than 205.53 cm/ ten canes was obtained by Elhag etal, 2007. The lowest length was 158.67 cm / ten canes and demonstrated by White Nile. Through these result all Industries were lowest than (236.37cm) demonstrated by Ongin'jo and Olweny, 2011). Also lower than standard limit 237Cm / ten canes.

Cane nods number: more nod undesirable due to increase fiber %

Table 4.1 showed that the mean value of Cane nods number for all samples collected from Sudanese sugar Industries was (18.61 Nods per ten canes). It was found that the highest nods numbers were recorded by Industries White Nile, Assalaya, Sennar, Guneid and New Halfa while the lowest nods number was 11.0 Nods per ten canes and recorded by factory Kenana. Theses result higher than standard limit (13.50 Nods per ten canes) and best than 21.57 Nods per ten canes was obtained by Elhag et al, 2007.

The chemical properties of Sugar Cane samples collected from the Sudanese Sugar Industries season, 2017:

Brix content: (Total Soluble Solids): plays an important role in determining the sugar recovery per cent of the sugarcane.

Table 4.1 showed that The mean value Brix % of cane for all samples collected from Sudanese sugar Industries was (20.82 %). the highest Brix % was recorded by factory Kenana while the lowest percentage was 19.0 % and recorded by factory White Nile. all samples Industries was highest than (12.58%) and (18.99%) that were reported by (Birkett, 1977) and (Onginjo' and Olweny, 2011) respectively. The differences in Brix values between Industries White Nile, Guneid and New Halfa are not significant at of significance level of 0.05%. The specification recommended that the Brix % of cane must be ranged between 18 – 23% according to South African Sugar Technologists, Association (SASTA, 2009). Through these results all samples Industries were within acceptable limits.

Pol content: The sucrose % is useful in deciding the quality of sugarcane and it influences the sugar recovery and sugar production in sugar mill.

The mean value of cane Pol % for all samples collected from Sudanese sugar Industries was (19.12 %). It was found that the highest Pol was 21.3 % and recorded by factory Kenana while the lowest value was 17.0 % and recorded by factory White Nile followed by factory Guneid and factory New Halfa where the differences between these Industries were not significant. All samples Industries were highest than (15.80%) and (16.97%) that were reported by (Birkett, 1977) and Ongin'jo and Olweny, 2011) respectively. The specification recommended that the Pol % of cane must be ranged between 14 – 21% according to South African Sugar Technologists, Association (SASTA, 2009). Through these results all samples Industries were within acceptable recommended range.

Purity content:

In case of Purity, The mean value of sugar cane Purity for all samples collected from Sudanese sugar Industries was (92.48 %). the highest value was demonstrated by factory Kenana and Assalaya whereas the lowest purity was shown by factory White Nile, Industries Sennar, Guneid and New Halfa recorded purity of 91.2 %, 91.5 and 91.7 % respectively and there was no significant difference between the values. Through these result all Industries were higher than (89.37%)

demonstrated by Ongin'jo and Olweny, 2011) expect factory White Nile was match with this result. The specification recommended that the Purity % of sugar cane must be ranged between 77 – 93.5 % according to South African Sugar Technologists, Association (SASTA, 2009). Through these results all samples Industries were within recommended range.

Reducing sugar:
Table 4.1 showed that the mean value of reducing sugar cane for all samples collected from Sudanese sugar Industries was (0.387 %). It was ranged from 0.507 % to 0.337 %. Percentage of reducing sugar recorded by the six Industries showed no significant difference at significant level 0.05%.

pH meter content: high Ph meter desirable due to preventive sucrose performed from deterioration of analysis to monosaccharide's as well as increase crystallization process.
The mean value of pH sugar cane for all samples collected from Sudanese sugar Industries was (5.32).The highest pH was recorded by Industries Kenana, White Nile, Assalaya and Sennar where the differences were not significant at level of significant 0.05%. The lowest pH was shown by Industries Guneid and New Halfa. There no recommended range for sugar cane pH to comparing it.

Fiber content:
The mean value of Fiber content of cane for all samples collected from Sudanese sugar Industries was (16.93 %). The highest fibers percentage was recorded by Industries 5 (19.7 %) while the lowest percentages were recorded by Industries Kenana, White Nile, Assalaya , Sennar and New Halfa of range from 16.03 % to 16.74 %. all samples Industries was highest than (14.48%) that was reported by (Birkett, 1977). The specification recommended that the fiber % of cane must be ranged between 15 – 20% according to South African Sugar Technologists, Association (SASTA, 2009). Through these results all samples Industries were within the recommended range.

Moisture content:
In case of moisture content, the mean value of moisture content was (66.55%) with range from 65.19 % to 66.97%.the analysis of variances revealed there is no significant differences between all samples Industries at level of significant 0.05%. The specification recommended that the moisture % of cane must be ranged between 55 – 65% according to South African Sugar Technologists, Association (SASTA, 2009). Through these results all samples Industries were higher than recommended range.

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Table (4.1) the physical properties of Sugar Cane collected from the Sudanese Sugar Industries season, 2017:

Industries	Weight Kg per ten stalks	Length Cm per ten stalks	Nods per ten stalks
Kenana	(0.82)A±0.09	(233.33)A±8.33	(11.00)B±2.00
White Nile	(0.56)C±0.07	(158.67)C±26.16	(19.00)A±3.46
Assalaya	(0.78)A±0.15	(220.67)AB±2.08	(20.67)A±0.56
Sennar	(0.71)B±0.11	(217.00)B±7.21	(20.33)A±2.52
Guneid	(0.68)B±0.08	(209.00)B±14.93	(19.67)A±0.58
New Halfa	(0.68)B±0.09	(215.33)B±6.03	(21.00)A±1.73
Means	**0.704**	**209**	**18.61**
S. Limits	**1.58**	**237.0**	**13.50**

S. Limits according to South African Sugar Technologists, Association (SASTA, 2009).

* Any means values having different superscript letter(s) in each Colum are significant different ($p \leq 0.05$).

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Table (4.2) the chemical properties of Sugar Cane collected from the Sudanese Sugar Industries season2017:

Industries	Brix % per ten stalks	Pol % per ten stalks	Purity % per ten stalks	R.S % per ten stalks	pH Meter per ten stalk	Fibers % per ten stalks	Moisture % per ten stalks
Kenana	(22.97)A±0.22	(21.27)A ±0.04	(92.60)A±0.78	(0.507)A±0.19	(5.67)A±0.06	(16.58)B±0.52	(65.19)A±0.81
White Nile	(19.00)C±0.44	(17.00)E ±0.26	(89.49)C±2.73	(0.323)A±0.04	(4.03)C±0.06	(16.03)B±0.63	(65.32)A±1.33
Assalaya	(21.76)B±0.63	(20.04)B ±1.15	(92.04)A±3.04	(0.413)A±0.04	(5.37)B±0.54	(16.19)B ±1.34	(67.01)A±1.11
Sennar	(21.62)B±0.96	(19.71)C ±0.22	(91.17)B±4.80	(0.383)A±0.06	5.20)B±0.20	(16.27)B±0.60	(66.02)A±1.09
Guneid	(19.29)C±0.25	(17.65)E ±0.20	(91.49)B±1.39	(0.337)A±0.05	(5.10)B±0.17	(19.73)A±2.07	(66.97)A±1.33
New Halfa	(19.62)C±0.96	(18.01)DE ±0.6	(91.68)B±1.23	(0.360)A±0.14	(5.57)A±0.38	(16.74)B±0.61	(66.80)A±1.02
Means	**20.82**	**19.11**	**92.476**	**0.387**	**5.32**	**16.92**	**66.552**
S. Limits	**18 – 23%**	**14 – 21.5%**	**77 – 93.5%**	**-**	**-**	**15 – 20 %**	**55 – 65 %**

S. Limits according to South African Sugar Technologists, Association (SASTA, 2009).

* Any means values having different superscript letter(s) in each Colum are significant different ($p \leq 0.05$).

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Determination the physical properties of raw sugar samples collected from the Sudanese Sugar Industries at season 2017:

Colour IU of raw Sugar:
The mean value of sugar Colour IU for all sugar samples collected from Sudanese sugar Industries was (948.67IU).Table (4.7) Showed that the highest Colour was 1460.0 and recorded by Guneid .While the lowest values were 360.06 and 400.01recorded by White Nile and Assalaya respectively. The differences in Colour values between Industries White Nile and Kenana are not significant at significance level 0.05%. The specification Limits of Colour must be ranged from (1000 – 11200IU) according to International commission for uniform methods of sugar analysis (ICUMSA, 1994). In the way of these results the samples obtained from Industries Kenana and White Nile were within recommended range while the Industries Assalaya and Sennar were less than recommended range and the Industries Guneid and New Halfa were higher than recommended range.

Mean Apparatus (M.A in mm) of raw Sugar:
The mean value of sugar Mean Apparatus for all sugar samples collected from Sudanese sugar Industries was (32.86 mm). The highest Mean Apparatus was 37.6 mm recorded by Guneid and the lowest values were 30.0, 31.0 and 30.7mm recorded by White Nile, Sennar and New Halfa respectively. The differences in Mean Apparatus values between Industries White Nile, Sennar and New Halfa are not significant at significance level 0.05%. The specification Limits of Mean Apparatus must be ranged from (30–35mm) according to International commission for uniform methods of sugar analysis (ICUMSA, 1994). In the way of these results all samples Industries within than satisfactory limits accepted Industries Guneid was exceeded critical limit.

Coefficient of Variation (C.V %) of raw Sugar:
The mean value of sugar Coefficient of Variation for all sugar samples collected from Sudanese sugar Industries was (1.49 **%).**
Showed that the highest Coefficient of Variation was 1.59 % recorded by Guneid and the lowest value was 1.43**%** and recorded by New Halfa. The statistical analysis discovered there are significant differences between all Industries under this study. The specification Limits of Coefficient of Variation must be less than (0.08%) according to International commission for uniform methods of sugar analysis (ICUMSA, 1994). Through these results all samples Industries were higher than the recommended limit.

Dust percentage (%) of raw Sugar:
The mean value of sugar Dust percentage for all sugar samples collected from Sudanese sugar Industries was (1.49 %).
Showed that the highest Dust percentages of sugar were 2.05% and 2.01% and recorded by Industries Kenana and White Nile respectively. While the lowest Dust percentage were 1.29 and 1.30 % and recorded by Sennar and New Halfa. The statistical analysis revealed there are significant differences between Industries Kenana, White Nile and between Industries Sennar and New Halfa. The specification Limits of Mean Apparatus must be ranged from (1- 2 %) according to International commission for uniform methods of sugar analysis (ICUMSA, 1994).

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The chemical parameters of raw Sugar samples collected from Sudanese Sugar Industries at season 2017:

Pol (%) of raw Sugar: The study results showed in table (4.8). That the mean the mean value of sugar Pol for all samples collected from Sudanese sugar Industries was (98.9 %). the significantly highest Pol value was 99.75 % recorded by Assalaya and flowed by Sennar (99.60%). while significantly lowest values were (98.03 % and 98.24%) and recorded by the rest Industries. the statistical analysis revealed there is significant differences between Assalaya and Sennar respectively and between White Nile and Guneid at significant level 0.05%. The specification Limits of Pol must be ranged between (99.5 – 99.80%) according to South African Sugar Technologists, Association (SASTA, 2009).though the study results the Industries Assalaya and 4only were within specification range. Also according to International commission for uniform methods of sugar analysis (ICUMSA, 1994) the specification Limits of Pol must be not less than (98.9 %) Through these results Industries Kenana, Assalaya and Sennar were within the recommended limits while the rest Industries were less than recommended limits.

Purity (%) of Raw Sugar A:
The mean value of sugar Purity for all samples collected from Sudanese sugar Industries was (97.8 %). the significantly highest Purity value was 90.0 % recorded by Industries Sennar and New Halfa and flowed by Assalaya (98.7 %). while significantly lowest value was (97.0 %) and recorded by Guneid . The differences in Purity values between Industries Assalaya and New Halfa are not significant at significance level 0.05%. Through these results Industries Kenana, Assalaya Sennar and New Halfa were within the recommended limits while the rest Industries were less than recommended limits both established by (SASTA, 2009) 98.0 – 99.6% and (ICUMSA, 1994) 97.817% .

Purity (%) of Raw Sugar B:
The mean value of sugar Purity for all samples collected from Sudanese sugar Industries was (96.78 %). the significantly highest Purity value was 97.7 % recorded by White Nile and flowed by New Halfa (97.6 %). while significantly lowest value was (96.0 %) and recorded by Guneid . The differences in Purity values between all Industries were significant at significance level 0.05%. Through these results Industries White Nile, Sennar and New Halfa were within the recommended limits while the rest Industries were less than recommended limits both established by (SASTA, 2009) 97.0 – 98.0% and (ICUMSA, 1994) 96.78 % .

Moisture content of raw Sugar:
The study results showed in table (4.8). That the mean the mean value of Sugar Moisture % for all samples collected from Sudanese sugar Industries was (0.26 %). the significantly highest Moisture values were 0.65% and 0.68% recorded by Kenana and factory Guneid respectively. while significantly lowest value was 0.04% and recorded by Sennar. the moderate moisture content were 0.06% and 0.07% recorded by Industries Assalaya and New Halfa respectively. The analysis of variances indicate that there no significant differences between samples in Kenana and Guneid, also between Assalaya and New Halfa at significant level 0.05%. The specification Limits of moisture must be maximum (0.06%) according to International commission for uniform methods of sugar analysis (ICUMSA, 1994). These results indicate that the samples of Industries White

Nile, Assalaya and Sennar respectively, were within the recommended limits as well as the Industries Kenana, Guneid and New Halfa respectively, were higher than the maximum limits.

Ash content of raw Sugar:

The mean value of Sugar Ash **%** for all samples collected from Sudanese sugar Industries was (0.07 %). the significantly highest Ash value was 0.08% and demonstrated by White Nile flowed by Guneid respectively. while significantly lowest value was 0.06% recorded for each Kenana, Kenana, Sennar and New Halfa respectively. the statistical analysis revealed there is significant differences between White Nile with all Industries and between Guneid with all Industries as well as there no significant differences between Industries Kenana, Assalaya, Sennar and New Halfa respectively, at significant level 0.05%. The specification Limits of Ash must be maximum (0.08%) according to International commission for uniform methods of sugar analysis (ICUMSA, 1994). Through these results all samples Industries were within the recommended limits (all Industries were less than maximum standard.

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Table (4.7) the physical parameters of raw Sugar samples collected from Sudanese Sugar Industries at season 2017:

Industries	Colour IU	M.A in mm	C.V %	Dust %
Kenana	$(1100.8)^{C}\pm2.77$	$(35.1)^{B}\pm0.32$	$(1.54)^{AB}\pm0.02$	$(2.05)^{A}\pm0.11$
White Nile	$(1101.0)^{C}\pm2.39$	$(30.0)^{D}\pm0.65$	$(1.43)^{DE}\pm0.03$	$(2.01)^{A}\pm0.09$
Assalaya	$(360.06)^{E}\pm1.64$	$(32.8)^{C}\pm0.44$	$(1.52)^{B}\pm0.05$	$(1.00)^{B}\pm0.01$
Sennar	$(400.01)^{D}\pm1.88$	$(31.0)^{D}\pm0.74$	$(1.44)^{C}\pm0.03$	$(1.29)^{D}\pm0.07$
Guneid	$(1460.0)^{A}\pm4.67$	$(37.6)^{A}\pm0.93$	$(1.59)^{A}\pm0.02$	$(1.33)^{C}\pm0.13$
New Halfa	$(1270.1)^{B}\pm3.54$	$(30.7)^{D}\pm0.26$	$(1.43)^{D}\pm0.04$	$(1.30)^{D}\pm0.08$
The mean	**948.68**	**32.87**	**1.49**	**1.497**
S. Limit	**1000 – 1200**	**30 – 35**	**0.08**	**1- 2**

M.A = Mean Apparatus - C.V = Coefficient of Variation

S. Limit according to International commission for uniform methods of sugar analysis, ICUMSA, (1994).

* Any means values having different superscript letter(s) in each Colum are significant different ($p \leq 0.05$).

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Table (4.8) the chemical parameters of raw Sugar samples collected from Sudanese Sugar Industries at season 2017:

Industries	Pol % of Raw Sugar	Purity % SugarA	Purity % Sugar B	Moisture %	Ash %
Kenana	$(99.18)^{B}$ ±0. 10	$(98.3)^{B}$ ±0.65	$(96.3)^{D}$ ±0.11	$(0.65)^{A}$±0.01	$(0.06)^{B}$±0.00
White Nile	$(98.03)^{C}$ ±0.34	$(97.6)^{C}$ ± 0.24	$(97.7)^{A}$ ±0.18	$(0.05)^{C}$±0.03	$(0.08)^{A}$±0.03
Assalaya	$(99.75)^{A}$±0.98	$(98.7)^{AB}$ ± 0.41	$(96.7)^{C}$ ±0.21	$(0.06)^{B}$±0.00	$(0.06)^{B}$±0.02
Sennar	$(99.60)^{A}$± 0.09	$(99.0)^{A}$ ±0.37	$(97.5)^{B}$ ±0.55	$(0.04)^{CD}$±0.04	$(0.06)^{B}$±0.02
Guneid	$(98.24)^{C}$±0.31	$(97.0)^{D}$ ± 0.52	$(96.0)^{E}$ ±0.43	$(0.68)^{A}$±0.01	$(0.07)^{AB}$±0.05
New Halfa	$(98.6)^{BC}$ ±0.44	$(99.0)^{A}$ ± 0.29	$(97.6)^{AB}$ ±0.38	$(0.07)^{B}$±0.02	$(0.06)^{B}$±0.01
The mean	**98.9**	**97.8**	**96.78**	**0.258**	**0.065**
S. Limit	**98.9**	**97.817**	**96.783**	**MAX 0.06**	**MAX 0.08**

S. Limit according to International commission for uniform methods of sugar analysis, ICUMSA, (1994).

* Any means values having different superscript letter(s) in each Colum are significant different ($p \leq 0.05$).

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CONCLUSION AND RECOMMENDATIONS

The study was conducted in Sudanese Sugar Industries which include (Kenana, White Nile, Assalaya , Sennar, Guneid and New Halfa) to Evaluation the Quality parameters of sugar cane and raw sugar samples were collected from the Sudanese Sugar Industry according to (SASTA, 2009) and (ICUMSA,1994) standards.

The data were collected through laboratory tests concerned with quality parameters of sugar cane and raw sugar samples.

It was concluded that the some quality parameter of cane like Brix%, Pol%, Purity%, and Fiber % were satisfactory with quality standard in all Sudanese Sugar Industry, While the moisture % was higher than recommended range in all Industries.

It was concluded that the quality parameter of raw Sugar like Moisture % , Ash%, Colour IU, M.A%, C.V%, Dust %, Pol % and Purity % . In case of Moisture % all Industries online with standard except Industries Kenana and Guneid. In case of Ash% all Industries were online with standard. In case of Colour Industries Assalaya and Sennar were lower while the Industries Guneid and New Halfa were higher than satisfactory range. In case of C.V% all Industries were higher than recommended limit. In case of Dust Industries Kenana and White Nile were higher than critical maximum value respectively. In case of Pol% only Assalaya and Sennar was within optional perimeter. In case of Purity% for sugar A the Industries White Nile and Guneid were lower than recommended range.

Recommendations:

Sudanese Sugar Industry needs to establish proper quality assurance laboratories to help in monitoring quality and safety of raw materials and end productions.

Sudanese Sugar Industry needs to establish references range for quality parameters of sugar cane like weight, length, number of nods and pH.

More researches were required to determination the residual of fertilizers, herbicides and pesticides in sugar cane and sugar production

Sudanese Sugar Industry needs to establish proper time and manner to eliminating, prevention or redacting the growth of microorganism in processing line that can lead to deterioration of sugar production as well as reduction recovery.

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