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Original Research Article

Physicochemical Properties of Sugarcane Products (Sugar) at Halfa Elgadidah Sugar Factory - Sudan

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Abstract

Physicochemical analysis was carried out for products of sugarcane in an attempt to study the quality of main-product (sugar) from Halfa Elgadidah Sugar Factory at six periods (T1, T2, T3, T4, T5, T6) corresponding to (3, 6, 12, 24, 36 and 48) hours after harvesting, respectively, during 2007/2008 and 2008/2009 seasons. Randomized complete plot design with three replications was used in this study. The results revealed that the average levels of total soluble solids (TSS), sucrose, sweetness, reducing sugars, were 99.7%, 98.45%, 98.68%, 0.185%, Traces of ash were found in sugar samples, they did not exceed 0.04. Moreover, protein content not exceeding 1.0 in sugar samples, the colour ranged between 236–268 and between 233.7-285.3 (IU) for the two seasons respectively. The relative viscosity ranged between 0.888-0.913 and between 0.884 - 0.903. The kinematic (absolute) viscosity of the sugar solutions ranged between 1.896 and 1.915 and between 1.894-1.914 centistokes for the two seasons respectively. The pH values of the sugar solution were in the range of 6.93-6.98 and 6.92-6.98 for the two seasons respectively. The moisture content ranged between 0.19-0.21% for the two seasons. The results showed that the optimum duration from cut to mill to produce a qualified sugar not exceeding 6 hours after harvesting.

Keywords: Sugarcane, sugars, chemical, physical, properties, varieties.

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INTRODUCTION

Sugar from sugarcane is extracted today more than it was 60 years ago. It is processed as raw sugar at sugar mills and then further purified to refined white sugar in a sugar refinery, using energy intensive processes [1].

Sugarcane has many other uses beside the production of sugar. It is quite possible that further uses of sugarcane will be developed in the future, but even now it can be seen that sugarcane is a very important and useful plant crop worldwide [2].

The cane is burned to reduce the straw or trash and their undesirable components, but unfortunately, the protective surface is eliminated causing the cracks and burning the main tissue of storage. On the other hand, the time taken from cut to mill affects the decrease of the sucrose quantity. The sucrose loss is associated with the deterioration of the sugarcane.

- The research will be intended with the following objectives:
- To assess the extent of post-harvest deterioration of sugarcane.

Evaluation of the effect of time taken from harvesting to milling on sucrose quality and quantity.

MATERIALS AND METHODS

Comprehensive physical and chemical analysis were carried out for the main product of sugarcane (sugar) in an attempt to find the effect of the time taken from cut to mill on cane deterioration and consequently on the physical and chemical properties of the sugar from Halfa Algadidah Sugar Factory (Sudan) for seasons 2007/2008 and 2008/2009. Randomized complete plot design with three replications was used in this study. The analysis was conducted on samples from three varieties of cane (V1, V2 and V3); corresponding to Co-6806, Co-527 and Co-986 at six periods (T₁, T₂, T₃, T₄, T₅, T₆) corresponding to (3, 6, 12, 24, 36 and 48) hours after harvesting, respectively.

Laboratory analysis was carried out to determine physical and chemical characteristics to evaluate the effect of sugarcane deterioration on the quality and quantity of sugar. The analysis includes:

- Total soluble solids (Brix) using Automatic Digital Refractometer.
- The sucrose % (Pol) using Automatic digital Polarimeter.
- Reducing sugars by [12]
- Carbonated and sulphated ash.
- Nitrogen content and protein.
- Moisture content- Viscosity and pH value

RESULTS AND DISCUSSION

Tables 1 and 2 show the total soluble solids in sugar samples which ranged between 99.67 - 99.83 and 99.55 - 99.87% for the two seasons (2007/2008, 2008/2009) respectively. No significant difference at P ≤ 0.05 was found for the total soluble solids neither between cultivars nor at the different durations after harvest. The results are in agreement with those reported by [3-6]

The two tables, show the sucrose content of sugars which ranged between 98.41-98.95% for season 2007/2008, and between 98.38–98.47% for season 2008/2009. The results indicated no significant differences at $P \leq 0.05$ between cultivars. The results revealed a significant difference for the different durations after harvesting. There was a little difference in sucrose content, when measured by chromatographic methods (TLC), which ranged between 97.50-97.89%. These differences were due to the false readings caused by the presence of dextran which rotated the polarized light positively three times as much as sucrose. These results are in agreement with that stated by [3-6].

The above tables, show the sweetness (purity; sucrose $\times 100/T.S.S$), which ranged between 98.58 - 99.18% and 98.57 - 98.77%, for the two seasons 2007/2008, 2008/2009 respectively, and ranged between 98.64 - 99.03% and 97.71 - 98.15% for the two seasons when sucrose was measured by chromatographic techniques, which are more accurate than that measured by polarimeter, due to the presence

of dextran. These results are in agreement with those stated by [3-6]

As shown in the same tables, the values of reducing sugars ranged between 0.1830 - 0.1847 percent for season 2007/2008, and between 0.1833-0.1913 percent for season 2008/2009. No significant differences were found among the three varieties, but significant differences were found at the different times after harvesting at P ≤ 0.05 The results are in agreement with that stated by [3, 4, 7].

Tables 1 and 2 show the mean values of nitrogen, protein and ash content in the final product (sugar) which ranged between 0.140-0.157%, 0.88-0.984%, 0.019–0.022 as carbonated ash and 0.033-0.035as sulfated ash respectively. The results show no noticeable difference at $P \le 0.05$, between the three cultivars, at the different times after harvesting. The results are related to the results stated by [3-6, 8].

Tables 3 and 4, illustrate the evaluation of colour of the final product (sugar) among the three cultivars at different durations after harvesting. The colour ranged between 236 ICOMSA unit (IU) as the lowest value and maximum value 268 (IU) for the season 2007/2008, and ranged between 233.7 (IU) as the lowest value and maximum value 285.3 (IU) for the season 2008/2009. No significant differences at $P \leq 0.05$ were found within the cultivars, but highly significant differences were found at the different times after harvesting. The results are in agreement with that found by [9, 10].

Table 3 and 4 show also the mean values of the viscosity, pH of sugar solution and moisture content. It ranged between0.888–0.913 and between 0.884–0.903. The kinematic (absolute) viscosity of the sugar solutions ranged between 1.896 and 1.915 and between 1.894–1.914 centistokes for the two seasons respectively. The pH values range between 6.90 - 6.98, while moisture ranges between 0.19 - 0.21 respectively. These results are in accordance to [5, 11].

Time hours	Sucrose%		TSS	Sweetness		Red. sugars	N%	Protein	Ash%	
	(1)	(2)		(1)	(2)			%	(C)	(S)
3	98.26 ^d	97.61 ^b	99.67 ^d	98.58 ^d	98.78 ^b	0.1830 ^a	0.157 ^a	0.981 ^a	0.020^{a}	0.033 ^a
6	98.51 ^{bc}	97.51 ^c	99.83 ^{dc}	98.68 ^c	98.66 ^c	0.1837 ^a	0.140 ^a	0.88^{a}	0.022 ^a	0.035 ^a
12	98.41 ^c	97.51 ^c	99.79 ^c	98.62 ^{cd}	98.64 ^c	0.1840 ^a	0.153 ^a	0.956 ^a	0.019 ^a	0.033 ^a
24	98.43 ^{bc}	97.50 ^c	99.80 ^{bc}	98.63 ^{cd}	98.69 ^c	0.1833 ^a	0.153	0.956 ^a	0.020 ^a	0.034 ^a
36	98.57 ^b	97.54 ^c	99.75 ^b	98.82 ^b	98.68 ^c	0.1853 ^a	0.147 ^a	0.919 ^a	0.021 ^a	0.035 ^a
48	98.95 ^a	97.89 ^a	99.77 ^a	99.18 ^a	99.03 ^a	0.1847 ^a	0.143 ^a	0.894 ^a	0.020 ^a	0.035 ^a
LSD	0.1409	0.0705	0.0997	0.0575	0.0814	0.0129	0.0129	0.0705	0.0129	0.0129
Error	0.003	0.012	0.006	0.004	0.002	0.0001	0.0001	0.003	0.0001	0.0001
CV%	0.05	0.11	0.08	0.01	0.05	1.00	5.65	5.90	6.05	2.40

Table-1: Chemical composition of final product (sugar) at different durations after harvesting (season, 2007/2008)

(1)= Polarimetric. (2)= Chromatographic. (C)= Carbonated ash. (S)= Sulphated ash

Mean values with the same letter within the same column are not significantly different.

LSD: Least significant different. CV: Coefficient of variation.

Error: Error means squire.

Time hours	Sucrose%		TSS	Sweetness		Red. Sugars	N%	Protein Ash%		
	(1)	(2)		(1)	(2)			%	(C)	(S)
3	98.38 ^a	97.71 ^a	99.55 ^b	98.77 ^a	98.15 ^b	0.1817^{a}	0.150^{a}	0.94 ^a	0.021 ^a	0.034 ^a
6	98.46 ^a	97.61 ^b	99.79 ^a	98.67 ^b	97.82 ^c	0.1833 ^a	0.143 ^a	0.984 ^a	0.021 ^a	0.035 ^a
12	98.45 ^a	97.54 ^c	99.83 ^a	98.62 ^{bc}	97.71 ^c	0.1833 ^a	0.153 ^a	0.956 ^a	0.019 ^a	0.034 ^a
24	98.47 ^a	97.52 ^c	99.84 ^a	98.63 ^{bc}	97.68 ^c	0.1860^{a}	0.150 ^a	0.94 ^a	0.020^{a}	0.033 ^a
36	98.41 ^a	97.51 ^c	99.84 ^a	98.57 ^{cd}	97.67 ^c	0.1890 ^a	0.147 ^a	0.919 ^a	0.021 ^a	0.034 ^a
48	98.40 ^a	97.50 ^c	99.87 ^a	98.54 ^d	97.63 ^a	0.1913 ^a	0.147 ^a	0.919 ^a	0.020^{a}	0.034 ^a
LSD	0.0997	0.0405	0.108	0.0705	0.0405	0.0129	0.0129	0.0705	0.0129	0.0129
Error	0.006	0.001	0.007	0.001	0.003	0.0001	0.0001	0.003	0.0001	0.0001
CV%	0.08	0.03	0.8	0.03	0.06	0.80	5.90	5.65	6.05	2.40

Table-2: Chemical composition of final product (sugar) at different durations after harvesting (season, 2008/2009)

(1)= Polarimetric. (2)= Chromatographic. (C)= Carbonated ash. (S)= Sulphated ash Mean values with the same letter within the same column are not significantly different.

LSD: Least significant different.

CV: Coefficient of variation.

Error: Error means squire.

Table-3: Physical properties of final product (sugar) at different durations after harvesting (season, 2007/2008)

Time hours	Moisture	Colour	Viscosity		pН
	%	(IU)	(R)	(K)	
3	0.201 ^a	236 ^d	0.894 ^b	1.896 ^a	6.93 ^{ab}
6	0.20^{ab}	237 ^b	0.888 ^b	1.896 ^c	6.93 ^{ab}
12	0.19 ^c	244 ^c	0.913 ^a	1.915 ^c	6.96 ^b
24	0.21 ^{ab}	247 ^b	0.911 ^a	1.909 ^{ab}	6.95 ^{ab}
36	0.21 ^{ab}	262 ^a	0.913 ^a	1.903 ^{bc}	6.98 ^a
48	0.19 ^{bc}	268 ^a	0.910 ^a	1.904 ^{ab}	6.95 ^{ab}
LSD	0.0129	0.692	0.0129	0.0129	0.705
Error	0.0001	0.289	0.0001	0.0001	0.003
CV%	8.35	0.22	1.43	0.65	0.73

(IU) = ICUMSA unit. (R) = Relative viscosity. (K) = kinematic (absolute) viscosity.

Mean values with the same letter within the same column are not significantly different.

LSD: Least significant different.

CV: Coefficient of variation.

Error: Error means squire.

Table-4: Physical properties of final product (sugar) at different durations after harvesting (season, 2008/2009)

Time hours	Moisture	Colour	V1scos1ty		рН
	%	(IU)	(R)	(K)	
3	0.21 ^a	233.7 ^e	0.884 ^b	1.894 ^a	6.93 ^{ab}
6	0.20^{ab}	246.7 ^d	0.890^{b}	1.896 ^c	6.92 ^{ab}
12	0.19 ^c	257.3°	0.903 ^a	1.905 ^c	6.90 ^b
24	0.20^{ab}	275.7 ^b	0.901 ^a	1.900 ^{ab}	6.95 ^{ab}
36	0.20^{ab}	278 ^{ab} .	0.903 ^a	1.913 ^{bc}	6.98 ^a
48	0.19 ^{bc}	285.3 ^a	0.912 ^a	1.914 ^{ab}	6.92 ^{ab}
LSD	0.0129	7.150	0.0129	0.0129	0.705
Error	0.0001	30.889	0.0001	0.0001	0.003
CV%	8.35	2.12	1.43	0.65	0.73

(IU)= ICUMSA unit. (R)= Relative viscosity. (K) = kinematic (absolute) viscosity

Mean values with the same letter within the same column are not significantly different.

LSD: Least significant different. CV: Coefficient of variation.

Error: Error means squire.

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