Substitution of Sugar Cane with Sweet Sorghum Stalks in Black Honey Processing

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ABSTRACT

Cane syrup or treacle is locally known as black honey in Egypt. It is essentially concentrated cane juice without removal of any sucrose. Sorgo or sorghum syrup is obtained by concentration of the juice expressed from the sorghum stalks. Using Sweet sorghum as a source of edible syrup may lead to increase syrup production. This work was carried out to studying physicochemical and sensory evaluation of syrup produced from sugar cane and sweet sorghum. Also, studying effect of harvesting age or maturity stage and treatment of juice by pre-heating at 100±0.5°C on technological quality characteristics of syrup produced from sugar cane and sweet sorghum.

The results indicated that sugar cane juice contained the higher values of total soluble solids % (TSS%), purity %, total solids %, sucrose %, total sugars % , ash % and pH value than sweet sorghum juice which had the higher values of color (ICUMSA-Unit), moisture %, reducing sugars % , total nitrogen %, total lipids %, titratable acidity and non-sucrose substances % (NSS%). There were an increase in TSS %, purity % and pH value of cane juice and sorghum juice with progress of the maturity stage, while, color and NSS %,showed a reverse trend . It could be observed that pre-heating led to reduction in TSS %, color and NSS % of juice, while purity % juice is increased.

Sugar cane syrup contained the highest values of purity % and pH value and total solids %, sucrose % and total sugars % than sorghum syrup which had the higher values of NSS %, moisture %, color, reducing sugars %, total nitrogen %, total lipids %, ash % and titratable acidity. Pre-heating of juice led to reduce the purity %, color and viscosity % of syrup.

It is noteworthy here to mention that sorghum syrup at ripe stage and pre-heating of extracted juice at 100±0.5°C was preferable for sorghum syrup production from one technological point of view under El-Minia governorate conditions. Accordingly, high sensory scoring of sorghum syrup compared with cane syrup at age of 12 months is considered economically beneficial.

Key words: *Sugar cane, cane juice, cane syrup, black honey, treacle, sweet sorghum, sorghum juice, sorghum syrupsorgo, physicochemical properties and sensory characteristics.*

INTRODUCTION

Cane syrup or treacle is considered as a popular food and form an important part of the diet of farmers in the village all over Egypt due to its valuable nutritional properties as well as its low price. It is essentially concentrated cane juice without removal of any sucrose. It is locally known as black honey in Egypt. It is a popular foodstuff, being a cheaper source of calories. It is produced from sugar cane (Saccharum Officinarum L.) whose procurement price to the sugar factories are increasing and quantities delivered are decreasing **(Abbas *et al.*, 1997).**

Sweet sorghum (Sorghum bicolor L. Moench) is processed principally for the production of table syrup. Sorgo or sorghum syrup is obtained by concentrating of the juice extracted from the sorghum stalks. Sweet sorghum is considered to be one of the additional sugar crops suggested to increase the syrup (black honey) production. The name 'sweet sorghum' is used to identify varieties of sorghum that are sweet and juicy. These sweet varieties are also called sugar sorghum **(Abbas and Ferweez, 2006).**

Using Sweet sorghum as a source of edible syrup may lead to increase in syrup production. It has a lower water and nitrogen requirement than sugar cane. It has a short period of vegetation and it may be grown on a wide range of soil types than either sugar cane or sugar beet. The great advantage or profitable of sweet sorghum was attributed to lower cost of planting and all agricultural and agronomical practices, beside its short duration in the soil, i.e. about 120 days **(Triebold and Aurand, 1963; Nour *et al.*, 1971; Freeman and Boadhead, 1973; Smith and Reeves, 1981; Mokadem *et al.*, 1999; Abo-El-Wafa and Abo-El-Hamd, 2001; Abbas and Taha, 2000 & CCSC, 2009).**

The results of **Taha, 1990; Mohamed, 1997 & Abbas and Taha, 2000** revealed that harvesting ages of sugar cane (11, 12 and 13 months), or maturity stages, i.e. milk, dough and ripe stages, were one of the most important factors affecting quantity and quality of cane syrup or sorghum syrup. They indicated that brix %, sucrose % and purity % of cane or sorghum juice and consequently in cane or sorghum syrup and syrup extraction % progressively increased with the increase of cane age at harvest or at maturity from milk stage to dough and ripe stages, respectively. However, stripped stalks yield (ton/fed.), juice extraction % and reducing sugars % of cane or sorghum juice and consequently its syrup showed progressive decreased with increase cane age at harvest or at maturity from milk stage to dough and ripe stages, respectively.

It is known that, heating of cane juice to the boiling point and at ordinary pressure led to reduce or remove precipitate form non- sugar substances resulting increase in the purity of final syrup and development of color **(Hurst, 1982).**

So, the objective of this work was carried out to studying physicochemical and sensory evaluation of syrup produced from sugar cane and sweet sorghum. Also, studying effect of harvesting age or maturity stage and treatment of juice by pre-heating at 100±0.5°C on ntechnological quality characteristics of syrup produced from sugar cane and sweet sorghum.

MATERIALS AND METHODS

This study was conducted at Mallawi Agric. Res. Station, El-Minia governorate, Egypt, during 2007/2008 and 2008/2009 seasons for sugar cane, while 2008 and 2009 seasons for sweet sorghum. This paper focus on harvest age or maturity stage and treatment of juice extracted from sugar cane or sweet sorghum stalks by pre-heating (100±0.5°C) for evaluating quality of syrup produced from sugar cane or sweet sorghum.

The variety of sugar cane (Saccharum officinarum L.) namely G.T.54-9 and locally known among growers as C9 and variety of sweet sorghum (Sorghum bicolor L. Moench) namely Honey were used. Three different harvesting ages of sugar cane 11, 12 and 13 months (plant cane), and three different maturity stages of sweet sorghum, i.e. (1) milk stage (age 90 days from planting) where the seeds contain a thin milk liquid, (2) dough stage (age 108 days) where the seeds are firm and easily crushable between fingers, and (3) ripe stage (age 128 days) where the seeds are firm of sweet sorghum were studied. Clarification treatment of juice extracted from sugar cane and sweet sorghum stalks by pre-heating at 100±0.5°C was carried out to removing undesirable impurities from juice before concentration to obtain good syrup and determine the effect of this treatment on syrup quality.

Syrup processing:

The stripped stalks of sugar cane or sweet sorghum were passed through a three roller mill to extract the juice. The raw juice was screened through layers of clean cheesecloth to remove the large pieces of suspended matters. Then, it is evaporated in open stainless steel pan (capacity 6 liters), the concentration process was carried out as rapidly as possible, first using direct flame to boiling point , then, indirect using a hot plate (to TSS% about 73%, after cooling reached 75±0.5 %).

Data recorded:

The obtained data in this study were presented as an average of five runs at different ages of sugar cane, plants were harvested at different maturity stages of sweet sorghum. A sample of twenty stalks was taken at random to determine the following parameters:

1- Physical properties:

1-1-Total soluble solids % (apparent brix %) was determined by Brix hydrometer standardized at 20°C for juice, and by Abbè refractometer using a 1: 1 diluted sample at 20°C for syrup.

1-2- Apparent purity represents the percentage of apparent sucrose to the apparent brix.

1-3- Color of juice or syrup was evaluated by measuring the extinction of the samples using Spectrophotometer, and then the result was expressed in ICUMSA-Unit according to Mathur (1981).

1-4- pH value was determined by the ICUMSA (1994) method.

1-5- Viscosity of syrup (C.P.) was determined using Brookfield Viscometer (model R. V. F. with spindle No. 3) expressed as centipoises (C. P.) at 29°C and rotating at 10 r. p. m. according to Collins *et al.*, (1977).

1-6- Non- sucrose substances % (true brix %) was calculated by difference of apparent brix from sucrose.

2- Chemical analysis:

2-1-Mositure and total solids contents were determined as described by **ICUMSA (1994)** method GS 1 – 7 (Intl Commission 1994).

2-2-Sucrose, reducing sugars, total sugars, total lipids, total nitrogen and ash contents were determined according to the methods described in **A. O. A. C. (1995).**

2-3- Titratable acidity (TA) was determined by titration with NaOH solution (0.1 N) and using phenolphthalein as indicator. The acidity was calculated in terms of milliliters NaOH 0.10 N required to neutralized 100 gm of sample (**Chen and Picou, 1972).**

3- Productivity traits:

Both gross yield and stripped yield were determined by weighing the three guarded rows for each treatment, they were used to estimate the corresponding values per fed. During syrup processing and evaporation the rising scum skimmed off with a ladle. Juice, syrup and scum yields were determined by weighing the juice extracted, syrup produced and scum removed according to **Abbas and Taha (2000)**. Juice, syrup and scum extraction percent were calculated using the following equation:

Juice, syrup or scum extraction % = (Juice, syrup or scum yields (ton /fed.) × 100)/stripped stalks yield (ton /fed.)

4- Sensory evaluation

Sensory evaluation of syrup samples was carried out according to the method of **Collins *et al.*, (1977).** Judges were consisted of 10 staff members. Four sensory characteristics were evaluated: taste, consistency,aroma and preference. The judge scoring system was 10 points for each character.

RESULTS AND DISCUSSION

I – Physical properties and chemical composition of juice:

Details of various observation and determination for physical properties and chemical composition of juice extracted sugar cane and sweet sorghum were recorded in Tables (1 and 2). The data given in Table (1) indicated that sugar cane juice contained the highest values of total soluble solids % (TSS %), purity % and pH value than that of sweet sorghum which had the highest values of color and non-sucrose substances % (NSS %). This might be mainly due to surplus sugar formed in photosynthesis for sugar cane juice higher than other. Generally, there were a positively relationship between TSS % and sucrose %, consequently purity % of cane juice or sorghum juice. These results agree with those obtained by **Mohamed (1997) and Abbas *et al.*, (1997).**

Concerning harvest age or maturity stage, it could be observed that, it had a highly effect on TSS %, purity %, color, pH value, NSS %. There was an increase in TSS %, purity % and pH value of cane juice and sorghum juice with progress of the harvesting age or maturity stage of sugar cane or sweet sorghum, while, color and NSS %, reversely. These results might be due to an increase in sugar formed in photosynthesis in juice of sugar cane or sweet sorghum with progress of the harvesting age (11 to 13 months) or of the maturity stage from milk stage to ripe stage, respectively, consequently the increase in purity %. These results agree with those obtained by **Taha (1990); Taha *et al.*, (1994); Mohamed (1997) & Abbas and Taha (2000).**

Table (1): Physical properties of juice extracted from sugar cane and sweet sorghum as influenced by harvesting age or maturity stage and pre-heating at 100±0.5°C.

Physical properties	Sugar cane						Sweet sorghum					
	Harvesting age						Maturity stage					
	11 months		12 months		13 months		Milk stage		Dough stage		Ripe stage	
	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated
TSS %	20.80	20.41	22.10	21.80	22.80	22.60	15.80	15.30	16.50	16.30	17.70	17.45
Purity%	79.28	81.14	82.58	85.09	84.65	87.52	58.35	61.50	61.21	63.01	63.33	65.62
Color	1809	1768	1724	1675	1709	1621	2764	2548	2384	2235	2196	2087
pH	5.40	5.30	5.50	5.40	5.60	5.60	4.50	4.40	4.70	4.70	4.80	4.70
NSS %	4.31	3.85	3.85	3.25	3.50	2.82	6.58	5.89	6.40	6.03	6.03	6.00

Each value represents the mean of 5 samples

With regard to clarification treatment of juice extracted from sugar cane and sweet sorghum by pre-heating at 100±0.5°C. It could be observed that pre-heating led to reduce in TSS %, color and NSS % of juice and increasing purity % at different harvesting ages or maturity stages. These results might be due to reduction or removal of precipitate form non-sugar substances which led to increase in the purity of juice and decrease in TSS %, color and NSS % of juice at different harvesting ages or maturity stages. These results are in good agreement with those obtained by **Taha (1990); Taha *et al.*, (1994); Mohamed (1997) & Abbas and Taha (2000).**

The data recorded in Table (2) clarified that sugar cane juice contained the higher values of total solids %, sucrose %, total sugars% and ash % than sweet sorghum juice which had the higher values of moisture %, reducing sugars %, total nitrogen %, total lipids % and titratable acidity. Such data are in the same trend with the findings of several investigators **(Cowley and Smith, 1972 & Mohamed, 1997).**

Table (2): Chemical composition of juice extracted from sugar cane and sweet sorghum as influenced by harvesting age or maturity stage and pre-heating at 100±0.5°C.

Constitute	Sugar cane						Sweet sorghum					
	Harvesting age						Maturity stage					
	11 months		12 months		13 months		Milk stage		Dough stage		Ripe stage	
	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated
Moisture %	79.35	79.79	78.19	78.33	77.68	77.85	84.64	84.82	84.20	84.44	82.75	82.90
Total solids %	20.65	20.21	21.81	21.67	22.32	22.15	15.36	15.18	15.80	15.56	17.25	17.10
Sucrose%	16.49	16.56	18.25	18.55	19.30	19.78	9.22	9.41	10.10	10.27	11.21	11.45
Reducing sugars %	0.56	0.78	0.38	0.67	0.27	0.58	3.10	3.50	2.91	3.24	2.52	3.18
Total sugars%	16.88	17.51	18.80	19.20	19.60	20.30	12.80	13.40	13.50	14.00	14.30	15.20
Total nitrogen %	0.41	0.28	0.38	0.22	0.29	0.24	0.5'C8	0.38	0.41	0.32	0.34	0.27
Total lipids %	0.54	0.43	0.48	0.37	0.44	0.35	0.74	0.58	0.64	0.51	0.68	0.54
Ash %	0.65	0.68	0.71	0.75	0.78	0.82	0.51	0.56	0.58	0.62	0.61	0.64
Titratable acidity	20.00	22.00	16.00	18.00	14.00	17.00	50.00	53.00	41.00	43.00	32.00	35.00

Each value represents the mean of 5 samples

Regarding harvesting age or maturity stage, the results in Table (2) revealed that there was an increase in total solids %, sucrose %, total sugars % and ash % of juice with progress of the harvesting age or maturity stage of sugar cane or sweet sorghum. However, moisture %, reducing sugars %, total nitrogen %, total lipids % and titratable acidity of juice decreased with progress of the harvesting age or maturity stage of sugar cane or sweet sorghum. These results agree with those obtained by **Mohamed (1997).**

As for clarification treatment of juice as shown in Table (4), it could be observed that pre-heating of juice extracted from sugar cane or sweet sorghum by pre-heating at 100±0.5°C led to reduction total solids%, sucrose %, total nitrogen %, and total lipids %. Also, it led to an increase in moisture %, reducing sugars %, total sugars % and ash % of juice at different harvesting ages or maturity stages of sugar cane or sweet sorghum. These results were attributed to the pre-heating treatment which led to reduction of precipitate form non-sugar substances, resulting from decrease total nitrogen % and total lipids %. These results are in good agreement with those obtained by **Mohamed (1997) & Abbas and Ferweez (2006).**

II - Juice, syrup and scum extraction %:

Results in Table (3) showed that juice extraction % (JE%) and syrup extraction % (SE %) of sugar cane were higher than that of sweet sorghum. However, scum extraction % (Sc E %) was lower in sugar cane than sweet sorghum. This might be mainly due to that sugar cane had the higher values of juice yield (ton/fed.), TSS % and total sugar % and the lower value of NSS % than sweet sorghum. Generally, there were a reversely relationship between TSS % juice and SE %. Also, there were a positively relationship between NSS % juice and Sc E %. These results agree with those obtained by **Mohamed (1997) and Abbas *et al.*, (1997).**

Table (3): Juice, syrup and scum extraction progressively % as influenced by harvesting age or maturity stage.

Component	Sugar cane			Sweet sorghum		
	Harvesting age			Maturity stage		
	11 months	12 months	13 months	Milk stage	Dough stage	Ripe stage
Juice extraction%	61.76	55.60	55.36	59.54	55.21	51.61
syrup extraction%	12.82	13.47	14.11	9.52	10.5'C5	11.23
Scum extraction%	1.64	1.35	1.11	2.50	2.09	1.90

Each value represents the mean of 5 samples

Concerning maturity stage or harvest age, data in Table (3) demonstrated that there was an increase in SE % of sugar cane or sweet sorghum with progress of the harvesting age or maturity stage of sugar cane or sweet sorghum. However, JE % and Sc E % of sugar cane or sweet sorghum decreased with progress of the harvesting age or maturity stage. These results might be due to an increase in TSS % juice and total sugar % of sugar cane or sweet sorghum with progress of the harvesting age or maturity stage led to increase SE %. Stalk juice of sugar cane or sweet sorghum decreased with progress of the harvesting age or maturity stage, consequently, JE % decreased with progress of the harvesting age or maturity stage. However, NSS % juice of sugar cane or sweet sorghum decreased with progress of the harvesting age or maturity stage, consequently, Sc E % decreased with progress of the harvesting age or maturity stage. These results agree with those obtained by **Mohamed (1997) and Abbas *et al.*, (1997).**

III – Physical properties and chemical composition of syrup:

Tables (4 and 5) present the effect of evaporation process for juice on physical properties and chemical composition of syrup. The results obtained in Table (4) showed that a sugar cane syrup contained the highest values of purity % and pH value than sweet sorghum syrup which had the highest values of color and NSS %. This might be mainly due to sucrose % and pH value of cane juice was higher than other. Generally, there were a positively relationship between purity % juice and purity % syrup as well as pH value. These results agree with those obtained by **Mohamed (1997)** and **Abbas *et al.*, (1997).**

Concerning harvest age or maturity stage, it could be recorded from Table (4) that, it had a highly effect on purity %, color, pH value, non-sucrose substances % (NSS %) of cane or sorghum syrup. There was an increase in purity % and pH value of cane syrup and sorghum syrup with progress of the harvesting age or maturity stage of sugar cane or sweet sorghum, while, color and NSS % of syrup, were reversely. These results might be due to an increase in sucrose % and SE % of sugar cane or sweet sorghum with progress of the harvesting age or maturity stage of sugar cane or sweet sorghum. Consequently, there was an increase in purity % syrup and pH value with progress of the harvesting age or maturity stage of sugar cane or sweet sorghum. These results agree with those obtained by **Taha (1990); Taha *et al.*, (1994); Mohamed (1997) & Abbas and Taha (2000).**

Table (4): Effect of evaporation process on physical properties of syrup produced from sugar cane and sweet sorghum at different harvesting age or maturity stage and pre-heating at 100±0.5˚C.

Physical properties	Sugar cane						Sweet sorghum					
	Harvesting age						Maturity stage					
	11 months		12 months		13 months		Milk stage		Dough stage		Ripe stage	
	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated
TSS %	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
Purity%	55.68	53.40	63.88	59.01	66.37	61.64	36.80	34.41	40.5˚C3	38.28	43.87	40.13
Color	3982.0	3802.0	3796.0	3614.0	3762.0	3602.0	4365.0	4208.0	3915.0	3761.0	3863.0	3687.0
pH	5.40	5.40	5.50	5.50	5.60	5.60	4.40	4.40	4.80	4.70	4.90	4.90
Viscosity	1800.0	1750.0	1875.0	1850.0	1900.0	1875.0	2500.0	2350.0	2575.0	2550.0	3050.0	3000.0
NSS %	33.24	34.95	27.09	30.74	25.22	28.77	47.40	49.19	44.60	46.29	42.10	44.90

Each value represents the mean of 5 samples

With regard to clarification treatment of juice as shown in Table (4), it could be observed that pre-heating of juice extracted from sugar cane and sweet sorghum led to reduce the purity %, color and viscosity % of syrup. Also, it led to an increase in NSS % of juice at different harvesting ages or maturity stages. These results might be due to this treatment led to an increase in reducing sugars % juice and reduce precipitate form non- sugar substances % resulting from decreasing the purity %, viscosity and color of syrup. These results are in good agreement with those obtained by **Mohamed (1997) and Abbas& Ferweez (2006).**

The data in Table (5) clarified that sugar cane syrup contained the higher values of total solids%, sucrose % and total sugars % than sorghum syrup which had the higher values of moisture %, reducing sugars %, total nitrogen %, total lipids %, ash % and titratable acidity. These results might be due to that sucrose % and total sugars % of cane juice was higher than sorghum juice which had the higher values of reducing sugars %, total nitrogen %, total lipids % and titratable acidity than other. Such data are in the same trend with the findings of several investigators (**Mohamed, 1997 and Abbas &Ferweez, 2006).**

As for harvesting age or maturity stage, the results in Table (5) revealed that there was an increase in sucrose % of syrup with progress of the harvesting age or maturity stage of sugar cane or sweet sorghum. However, reducing sugars %, total nitrogen %, total lipids %, ash % and titratable acidity of syrup decreased with progress of the harvesting age or maturity stage of sugar cane or sweet sorghum. These results might be due to that sucrose % juice increased with progress of the harvesting age or maturity stage of sugar cane or sweet sorghum, while, reducing sugars %, total nitrogen %, total lipids %, ash % and titratable acidity of juice as shown in Table (2) decreased with progress of the harvesting age or maturity stage of sugar cane or sweet sorghum.These results agree with those obtained by **Mohamed (1997) and Abbas (2002).**

With regard to clarification treatment of juice as shown in Table (5), it could be observed that pre-heating of juice extracted from sugar cane or sweet sorghum led to reduce sucrose %, total nitrogen % and total lipids % of syrup produced from sugar cane or sweet sorghum at different maturity stages or harvesting ages. Also, it led to an increase in moisture %, reducing sugars %, total sugars % and ash % of syrup produced from sugar cane or sweet sorghum at different maturity stages or harvesting ages. These results might be due to this pre-heating treatment which led to a remove precipitate form non-sugar substances, resulting from decrease total nitrogen % and total lipids % of syrup. These results are in good agreement with those obtained by **Mohamed (1997) and Abbas & Ferweez (2006).**

Table (5): Effect of evaporation process on chemical composition of syrup produced from sugar cane and sweet sorghum at different harvesting age or maturity stage and pre-heating at 100±0.5°C.

Constitute	Sugar cane						Sweet sorghum					
	Harvesting age						Maturity stage					
	11 months		12 months		13 months		Milk stage		Dough stage		Ripe stage	
	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated
Moisture %	27.59	27.64	27.28	27.39	27.19	27.21	28.65	28.78	28.34	28.42	28.22	28.34
Total solids %	72.41	72.36	72.72	72.61	72.81	72.79	71.35	71.22	71.66	71.58	71.78	71.66
Sucrose %	41.76	40.05	47.91	44.26	49.78	46.23	27.60	25.81	30.40	28.71	32.90	30.10
Reducing sugars %	19.24	21.04	13.23	16.66	10.94	14.46	32.90	34.92	30.5°C	32.10	28.20	31.18
Total sugars %	63.32	63.21	63.70	63.45	63.50	63.21	62.26	62.10	62.70	62.52	63.00	63.00
Total nitrogen %	0.41	0.25	0.26	0.18	0.21	0.17	0.5°C1	0.24	0.43	0.26	0.39	0.23
Total lipids %	0.46	0.21	0.30	0.20	0.28	0.18	0.61	0.23	0.5°C2	0.21	0.41	0.18
Ash %	2.71	2.63	2.46	2.32	2.31	2.29	2.82	2.71	2.66	2.56	2.57	2.48
Titratable acidity	108.30	110.5°C2	101.00	108.30	97.50	103.20	180.10	188.00	170.50	176.71	167.82	172.00

Each value represents the mean of 5 samples

VI- Productivity traits:

The results obtained in Table (6) showed a differences between sugar cane and sweet sorghum in relation to biomass yield, stripped yield (clean stalks yield), forage yield, juice yield, bagasse yield and scum yield (ton/fed.) as well as syrup yield (ton/fed.). It could be pointed out that sugar cane had the higher values of the previous measured parameters than sweet sorghum. This pronounced influence might be attributed to the differences in the growth parameters which were surely reflected on biomas yield and stripped yield (ton/fed.) of sugar cane compared with sweet sorghum. These findings are in accordance with those reported by **Nour**

(1963); Taha *et al.*, (1994); Mohamed (1997) & Abbas and Ferweez (2006).

Table (6): Productivity traits (ton/fed.) of syrup produced from sugar cane and sweet sorghum as affected by harvesting age or maturity stage.

Component	Sugar cane			Sweet sorghum		
	Harvesting age			Maturity stage		
	11 months	12 months	13 months	Milk stage	Dough stage	Ripe stage
Biomass yield	61.09	64.70	60.88	41.71	36.81	33.10
Clean stalks yield	42.76	49.82	48.70	30.45	28.71	26.35
Forage yield	18.33	14.88	12.18	11.26	8.10	6.75
Juice yield	26.41	28.20	26.96	18.13	15.85	13.60
Bagasse yield	16.35	21.62	21.74	12.32	12.86	12.75
Syrup yield	5.48	6.71	6.87	2.90	3.03	2.96
Scum yield	0.70	0.67	0.54	0.76	0.60	0.50

Each value represents the mean of 4 replicates

V- Sensory evaluation of syrup:

The data represented in Table(7) showed sensory evaluation (taste, consistency, aroma and preference) of syrup samples produced from sugar cane and sweet sorghum at different harvesting ages and maturity stages (11, 12 and 13 months for sugar cane, as well as at milk, dough and ripe stages for sweet sorghum). It could be revealed from the results that sugar cane syrup contained the higher scores of taste, preference and aroma than sorghum syrup which had the higher score of consistency. This is to be expected because the higher value of sucrose % and lower value of titratable acidity of syrup were found in cane syrup than sorghum syrup. However, sorghum syrup had the higher score of consistency which might be due to the higher value of NSS %.

Regarding harvesting age or maturity stage, the results in Table (7) showed that the ripe stage of sorghum syrup contained the higher scores of taste and aroma scores while the lower scores recorded for milk stage. However, cane syrup produced from sugar cane at age of 11 months recorded the higher score of taste and the lower score of consistency. This result might be due to the higher and lower values of sucrose % of sorghum syrup were scored for ripe and dough stages, respectively, as shown in Table (5).

Table (7): Sensory evaluation of syrup* produced from sugar cane and sweet sorghum as affected by harvesting age or maturity stage and pre-heating at 100±0.5°C.

Organoliptic properties	Sugar cane						Sweet sorghum					
	Harvesting age						Maturity stage					
	11 months		12 months		13 months		Milk stage		Dough stage		Ripe stage	
	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated
Taste	9.20	9.70	9.00	9.10	9.00	9.20	7.50	7.80	7.90	8.10	7.90	8.50
Consistency	8.00	7.90	8.20	8.00	8.40	8.10	8.10	8.00	8.50	8.30	8.80	8.60
Aroma	8.50	9.00	8.70	8.90	8.70	9.00	7.70	7.90	7.90	8.00	8.10	8.30
Preference	9.00	9.20	9.20	9.30	9.20	9.30	8.10	8.30	8.30	8.50	8.40	8.70
Total score from 10	8.68	8.95	8.78	8.83	8.83	8.90	7.85	8.00	8.15	8.23	8.30	8.53

*** Scores one means of ten panellists.**

With regard to clarification treatment of juice as shown in Table (7), it could be observed that pre-heating of juice extracted from sugar cane or sweet sorghum by at 100±0.5°C led to an increase in taste, aroma and perference. Also, it led to a decrease in consistency of syrup at different maturity stages or harvesting ages. These results might be due to this treatment led to an increase in reducing sugars %, and minimize precipitate form non- sugar substances resulting from decrease total nitrogen % and total lipids % of syrup at different maturity stages or harvesting ages. These results are in good agreement with those obtained by **Mohamed (1997) and Abbas *et al.*, (1997).**

It is noteworthy here to mention that clarified sorghum syrup at ripe stage and pre-heating of extracted juice at 100±0.5°C was preferable for sorghum syrup production from technological point of view under El-Minia governorate conditions. Where, Maximizing sensory evaluation of sorghum syrup compared with cane syrup at age of 12 months is economical.

CONCLUSION

It could be concluded that sorgo was suitable for human's feeding and this applies to substitute of treacle or cane syrup. Whereas, sugar cane is considered the main source of sugar production and have always been a matter of great concern for the sugar industry technologists.

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الملخص العربي

استبدال قصب السكر بعيدان الذرة السكرية في صناعة العسل الأسود

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يعرف شراب القصب بالعسل الأسود فى مصر وينتج بتركيز عصير القصب دون إزالة بلورات السكر ، ونحصل على شراب الذرة السكرية بتركيز العصير المستخلص من عيدان الذرة السكرية وباستخدامه كمصدر للشراب القابل للأكل يؤدى الى زيادة إنتاج العسل. لذا أجرى هذا العمل لدراسة الصفات الفيزوكيميائية والتقييم الحسي للشراب المنتج من قصب السكر والذرة السكرية ، وكذلك دراسة تأثير ميعاد الكسر أو مراحل النضج ومعاملة العصير بالتسخين المبدئي على درجة 100 ± 0.5°م على صفات جودة الشراب الناتج منهما.

<u>وقد أوضحت النتائج المتحصل عليها على ما يلي</u> :

1- احتوى عصير قصب السكر على قيم اكبر من نسب المواد الصلبه الذائبة الكلية ، النقاوة ، المواد الصلبه ، السكروز ، السكريات الكلية ، الرماد ، والأس الهيدروجيني عن عصير الذرة السكرية الذي سجل قيم أعلى بالنسبة إلى اللون ، الرطوبة ، السكريات المختزلة ، النتروجين الكلى ، الليبيدات الكلية ، الحموضة القابلة للمعايرة والمواد غير السكرية.

2- سجلت زيادة فى نسب المواد الصلبه الذائبة الكلية ، النقاوة ، والأس الهيدروجيني لعصير القصب و الذرة السكرية مع تقدم مرحلة النضج بينما العكس حدث مع قيم اللون والمواد غير السكرية.

3- خفض التسخين المبدئي للعصير على درجة 100 ± 0.5°م نسب المواد الصلبة الذائبة الكلية ، اللون ، والمواد غير السكرية والعكس بالنسبة الى نسبة النقاوة.

4- احتوى شراب القصب على قيم اعلى فى نسبة النقاوة ، والأس الهيدروجيني المواد الصلبة الكلية ، السكروز ، والسكريات الكلية عن شراب الذرة السكرية الذى سجل قيم أعلى فى نسبة الرطوبة ، السكريات المختزلة ،النيتروجين الكلى ، الليبيدات الكلية ، الحموضة القابلة للمعايرة ، والمواد غير السكرية.

5- من الجدير بالذكر لن شراب الذرة السكرية عند مرحلة النضج ، والتسخين المبدئي على درجة 100 ± 0.5°م للعصير كانت نتائجه مفضلة لإنتاج شراب الذرة السكرية من وجهة النظر التكنولوجية تحت ظروف محافظة المنيا. وبناءا عليه فارتفاع التقييم الحسي لشراب الذرة السكرية مقارنة مع شراب القصب عند عمر 12 شهر يُعد اقتصادياً.