Assessment of the Effect of Transit Time Between Harvesting and Processing on the Physicochemical Quality Parameters of Preharvest Burnt Sugarcane

Abstract

Aim: This study was aimed at assessing the effect of time interval between harvesting and processing on the physicalandchemical quality parameters of pre-harvest burnt sugarcane

Study design: A qualitative experimental study design was carried out that involve random selection of samples and sent to laboratory for analysis

Place and Duration of Study: The study was carried out on July from 26th to 30th 2023 in Kilombero Valleylocated in the eastern part of Tanzania, between latitude 7 0 42'42'S and longitude 37 0 00'00'E.

Methodology: The NCO 376 variety of sugarcane used, that were cut below ground level, the tops removed, stalks tightened in bundles. The sample size was 15. each sample constituted of 30 burnt sugarcanestalks samples that were randomly collected and sent to laboratory for analysis after 24 ,72 and 120 hoursof storage. On every respective storage time, the samples were scratched with knife to remove external contaminants, the stalks were then milled using two roller machines to extract juice. The juice was filled and sealed in sterilized and labelled bottles ready for laboratory analysis. The laboratory analysis data collected were coded and entered in excel sheet and analysed using Statistical Package for Social Science (SPSS) version 26.

Result: The result shows the means values for pH, brix , pol, purity and weight decreased with increase in storage time whereas the means values for dextran, yeast and *Leuconostoc* increased with increase storage time The results revealed that purity values were satisfactory in all storage time levels as compared to SASTA standard purity values (97.0 – 98.0%), whereas mean values for brix and pol stored for 120 hours of storage time was not satisfactory.as compared to SASTA standard values for brix (18 – 23%) and pol (14 – 21%) .Dextran concentration was high as compared to South African Sugar Terminals (SAST) that maximum requirement for dextran is 150 mg/kg, dextran level as the measure of microbial deterioration was high in 72 and 120 storage hours indicating microbial contamination

Conclusion: Farmers and processors should be well informed about the consequence of delayed processing burned sugarcane to avoid economic loss for farmers and processors

Key words:*S. officinarum* deterioration, storage time, physical, biochemical changes, pre-harvest burning

1. INTRODUCTION

Sugarcane (*Saccharum officinarum*) isanimportant economic crop used for food and fuels. It is a member of the *Poaceae* family and grows in tropical and subtropical climates ([1]. It is composed of water (65-75%), sugars (11-18%), fibres (8-14%), and other soluble solids (12-23%) [2]. Sugarcane is very perishable and its quality deteriorate soon after harvest.Post-harvest deteriorationof sugarcaneincludes both qualitative and quantitative changes. These changes include formation of organic acid, decrease in weight due to water loss and loss of sugar concentration which in turn affect farmers income as they are paid based on sugar per ton. In addition,the deterioration rateincreased as a result of preharvest burning, cut to mil delays, and microbial infection [3]BecauseSugarcane contains highwatercontent (65-75%), it very susceptible to microbial growth that unturn utilizes sugar content such as sucrose and reduces the quality of final product.Thus, proper monitoring of sugarcane soon after harvestto ensure the quality of final sugar.Moreover, the quality of sugarcane depends on weight and sugar concentration which are used to establish selling price. In sugarcane sugar concentration is determined by either °Brix, as measure of soluble solids content, or Polarization (pol), a measure of sucrose[4]

In Tanzania, sugarcane is an agricultural crop grown in Morogoro, Kagera, Kilimanjaro, and the coastal regions of Tanzania. The sugar production is reported to be 378,000 metric ton which is still inadequate as compared to the estimated demand of 470,000 metric tons in 2020 [4], [5]In addition, productivity per hectare is also reported to be poor [6].Kilombero Sugar Company is Tanzania's largest sugar producer, accounting for 45% of total sugar production [7]. It produces 128,000 metric tons of sugar where 40% of raw sugarcane is supplied by farmers and 60% by the company itself[8]

Post-harvest loss is among the main causes of low sugar yields. Sugarcane post-harvest deterioration is hugely concerning to the sugar industry, whereby the delay between cutting and milling has been identified as a major cause of postharvest degradation[9]. This delay has adirect impact on the composition of sugarcane [1]and is linked to the presence of simple sugars[10]. Reducing downtime between harvest and processing is a win-win situation for both producers and processor[11].According to[11], the acceptable harvest to crush delayis between 4 to 6 days for South Africa, about 3 to 10 days for sub-tropical India, and around 36 to 48 hours for tropical India.Moreover, the average time between burn and crush., ranges from 2 to 4 days and is common in most sugar companies[12].

Sugarcane preharvest burning is a popular traditional practice aimed at easing harvest and transport operations and hence lowering harvesting costs[13]. The practice eliminates the leaves from the sugarcane stalk, making the manual cutting procedure easier[14].Similarly, preharvest burning facilitates the exercise of harvesting, transportation and cleaningmillable stalk[15].However,despite its benefits, sugarcane preharvest burning has been shown to reduce sugar recovery and processing efficiency if the cane is delayed deliveryto processing facilities [16]

Dextran is a bacterial polysaccharide compound that occurs in deteriorating sugarcane. It structurally made up of D-glucose with α-1,6- glucopyranosidic linkages within the main chain.Dextran is known to cause poor filtration, reduced evaporation and poor crystallization. eventually causing sucrose losses which contribute to

economic losses[17]. The burning of sugarcane prior to harvesting and mechanical harvesting is described as facilitating the invasion of sugarcane by microorganism particularly *Leuconostocspp* responsible for sucrose damage leading to the formation dextran. The reaction for the formation of dextran is catalyzed by dextransucrase the enzymes that is produced by *Leuconostoc spp*. The presence of dextran indicates the presence of microorganisms that cause sucrose inversion [18]

The duration between harvesting and milling has an impact on quality of sugarcaneas a raw material for sugar processing. Some studies found that delayeddeliveryof harvested burntsugarcane on time for milling has significant effect such as lower brix and sugar content, reduced purity, and sometime weight loss[19]. This has a severe impact on sugar quality and economics for both sugarcane manufacturer and producers/farmers[20];[21]

Severalstudies have been conducted on the influence of storage temperature from harvesting to processing burned sugarcane, with the majority of them focusing on sugarcane juice as a drink [1]; [22]; [23];[24]. However, limited studies have been conducted on the effect of time intervals (storage time) between harvesting and processing burnedsugarcane at ambient temperature in tropical conditions. Moreover, the ambient temperature of varies greatly from one sugar factory to another. Thus, the objective of this study is to determine effect of different storage times after harvesting burnt sugarcane on quality of sugar production.The study's findings are essential for the scientific community (processors) and sugarcane producers (farmers) as they will provide insight into how the time gap between the harvesting and processing process affects the physicochemical quality characteristics of sugarcane and suggest the minimum time required for maintaining the physicochemical quality of sugarcane as the raw material required for sugar production.

MATERIALS AND METHOD

2.1Experimental design,

A qualitative experimental designwas used to determine the effect of storage time on the physical, chemicaland microbial properties of harvested burnt sugarcane. Three different storage time were selected (24, 72, and 120 hours) as independent variables. Storage time has been selected on the basis of various studies that show harvesting, transportation, milling and other factors that are out of human control like weather condition take time. Moreover, sugarcane farms are located at varying distance combining these factors together contribute to a significantdelay in processing. With regardto Kilombero Sugar Company, the acceptable range time from burn to crush is five days. The dependent variables studied were pH, brix (as a measure of total soluble solids), purity, weight,pol and microbial infestation (i.e., yeast and *Leuconostocmesenteroides*).

2.2Study area

The study was carried out on July from 26th to 30th under environmental field condition where the minimum temperature ranged from 15.4 -19.0 ˚C and maximum temperature ranged from 28.5-29.5 ˚C

The research was carried out in KilomberoValley, where sugarcane is cultivated. It is located in the eastern part of Tanzania, between latitude 7 0 42'42'S and longitude 37 0 00'00'E. TheValley comprised of two close agricultural estates and sugar mills, Msolwa (in Kilomberodistrict) and Ruembe (in Kilosadistrict), which are located on opposing banks of the great Ruahariver and are linked together by a low-level bridge. Kilomberoagricultural estates comprise more than 8,000sugarcane growers

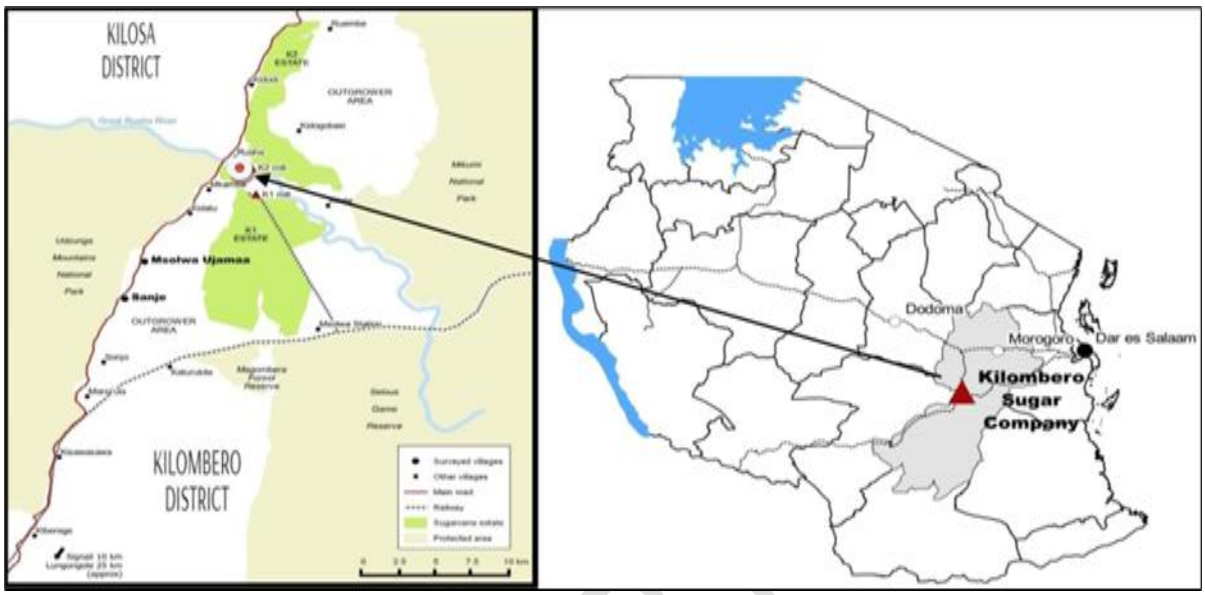

Figure 1. Map of studyareaKilombero Valley. [25]

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2.3Sample size estimation

The variety of sugarcane used in this study was NCO 376. The estimated sample size was 15 whichrepresents differentsugarcane farms (each farm equivalent to one acre) owned by different farmers. Each sample constituted of 30 burnt sugarcane stalks samples that were randomly collectedand sent tothe Department of Food Science and Agroprocessinglaboratory for analysis after 24 ,72 and 120 hours storage. The samples (15)were estimated using Kothari and Garg, (2014**)**as per equation 1

$$n = \frac{Z^2 * P(1-P)}{e^2} \text{.....1}$$

Where; n = sample size, Z = Standard variant at a given confidence level, for this study a 95% confidence level = 1.96, P = Standard deviation that will show how much the results will vary from each other and the mean number for this study (0.05) was used and e = acceptable error (the precision/ estimation error) is 0.11 for this study.

$$\boldsymbol{n = \frac{1.96^2 * 0.05(1-0.05)}{0.11^2} = 15} \text{.....2}$$

The samples of sugarcane stalks were cut below ground level, the tops removed, andthe stalks tightened in bundles and packed in perforated nylon bags for

transportation. The transportation took three hours, counting of the storage time after cutting the *S*sugarcane stalks. The samples were scratched with knife to remove external contaminants, the stalks were then milled using two roller machines to extract juice. The juice was filled and sealed in sterilized and labelled bottles

2.4Data collection

2.4.1Brix determination

Brix (total soluble solids) of extracted burnt sugarcane juice was measured using an Atago 3810 PAL-1 Digital Hand-Held Pocket Refractometer manufacture by Cole-Parmer. Calibration was performed prior to measuring the brix by zeroing the refractometer with distilled water. The recorded value was used as the water blank when the measurement was not 0.00°Bx at 20.0°C. The sample was put into the refractometer cell compartment in three sections and when the temperature stabilized at 20.0°C, the reading was recorded.

2.4.2Polarization determination

Polarization (abbreviated as pol) refers to the actual sucrose content expressed as a mass percent and determined by polarimeter by the optical rotation of polarized light flowing through a sugar solution. Polarization determines the purity of the sugar and provides the sucrose content as a mass percentage. It is the major benchmark used to determine the quality of the sugar. Sugar crystal is very near to 100% pure sucrose, pol is a good measure. The greater the polarization, the purer the sugar; the lower the polarization, the more the impurities in the sugar

Pol is determined according to South Africa Sugar Technologist Association Method, (2005).Pol is an estimation of sucrose concentration. Thepol was determined as per the [26]The polarimeter was used to determine the pol of the burnt sugarcane juice. The juice was clarified with lead sub-acetate powder before being filtered with paper (Whatman No. 91, S&S 3000). Then cleaned, the first 15 cm^3 of filtrate was discarded, and then 60 cm^3 was collected in a clean, dry beaker. After calibration of the polarimeter, the filtrate was put into the pol tube in three equal portions to achieve full displacement of the previous solution. Once stabilized, the reading was recorded. The polarimeter measurement was observed and recorded.

The polarimeter reading obtained, was then used in the formula for pol determination as per the Schmitz equation [26]

$$pol = \frac{\text{polarimeter reading}}{0.0000576 * Brix^2 + 0.014752 * \text{Brix} + 3.83545)} \quad \ldots\ldots 3$$

2.4.3Puritydetermination

The purity was determined as per South Africa Sugar Technologist Association Method, (2005). **Purity** was determined based on the pol value and brix value as indicated by the Schmitz equation [26]

$$Purity = \frac{\text{Pol}}{\text{Brix}} * 100 \quad \ldots\ldots 4$$

pH determination

The pH meter of the Edge Model HI2020 product of HANNA manufacturer was first calibrated at room temperature with buffer solutions of pH 4.00 and 7.00. About

200ml of juice was mixed in a 250 ml beaker before dipping the pH meter's glass electrode into it. The pH reading was taken whenthe pH meter was steady.

2.4.4Weight changes determination

Weight changes were determined after 24, 72, and 120 hours of storage using the laboratory analytical balance 200G/0.001G model manufactured by WANT Balance Instrument Co., Ltd. Six sugarcane stalks were selected at random from each sample, chopped into sections of 25 to 30 cm length to facilitate weighing and kept under ambient environmental condition. A laboratory weighing balance was used to quantify the weight in grams ofsample. The weighing balance was calibrated to zero to ensure correct reading. The weight of 30 bundles were weighed and recorded as per storage time.

2.4.5 *Leuconostocmesenteroides*.

Detection of *Leuconstocmesenteroides* bacteria producing dextran Preparation media and culturing was undertaken as follows: 23.5 grams from Sucrose Agar Media (S.A.M) Media was weighed and dissolved in 1000 ml of distilled water in a conical flask and then placed in a water bath at 40ºC for 10 minutes to dissolve the media. Then the media was placed in an autoclave for 20 minutes after reaching temperature 121ºC and pressure of 15bar, the media was removed and cooled at 40ºC. After the Inoculation of 1ml on each petri dish,15 ml of Sucrose Agar Media prepared above was poured into each Petri dish. All dishes were left for about 30 minutes at room temperature to solidify and then all Petri dishes were incubated at 31°C for 72 hours. Colonies were counted after 72 hours and results were expressed as colony-forming units per milliliter (CFU/1ml),(ICUMSA)

2.4.6Yeast

The yeast was determined according to ISO 21527 -2:2017 with some modifications. A 10mls sample was placed in a sterile sample bottle, then 90ml of sterile peptone water was added and mixed by shaking for two minutes to obtain first dilution, 1:10, and by using a micropipette of 1ml other dilutions 1:100, and 1:1000, were done, in which 1ml of 10^{-1}, 10^{-2} and 10^{-3} dilutions in duplicate were inoculated in the sterile petri dish, Molten Potatoes Dextrose Agar having temperature around 40-45 ^{o}C was poured and mixed thoroughly by rotating the petri dish clockwise and anticlockwise for five times. The prepared plates were incubated aerobically, lids uppermost in an upright position in the incubator at 25°C ± 1°C for 5 days.

2.4.7Dextran

Dextran was determined as per Roberts Copper Method. About 10 mls of sugar cane juice was pipetted and transferred into a 100 mL beaker, then 0.3 g of anal was added filtered and stirred followed by the addition of 40mls of alcohol and stirring. It stands for 5 minutes to form precipitate and precipitate filtered off on sintered glass filter on a rubber ring. Precipitate was washed five times with 80% ethyl alcohol, each time filtered with alcohol, and alcohol was drawn through precipitate. This step was important to remove sugar that might remain adsorbed to precipitate and interfere in the phenol-H_2S0_4 reaction.

When the last portion of alcohol wash has been completely drawn through precipitate, then precipitate plus filter aid is transferred to a 25 mL volumetric flask and the minimum amount of water was used for transfer.

Ten (10) mls of filtrate was taken for analysis in a plastic test tube followed by 2 mls 2.5N NaOH reagent solution, 2 mls of copper reagent solution and 0.2 g anal, filter aid. Then test tube containing the mixture of solution was boiled in a water bath for 5 minutes to precipitate Cu-dextran complex on filter aid, and cooled for 20 minutes and theprecipitate contained Cu-dextran complex filtered.

About 2 mls of 2N Sulfuric acid solution was poured into the ina sintered glass funnel and the vacuumwas turned on, sothe acid solution was drawn through the precipitate. This procedure was repeated, then precipitate rinsed with 2 mL H_20.The quantity of filtrate, which contains solubilized dextran was transferred to a 25 ml volume flask and diluted to volume with water. Two (2) mls of this solution was pipetted into the test tube and the procedure for the Phenol-H_2S0_4 test was followed as done in the standard dextran below.

Preparation of Dextran Standard Curve

Dextran Standard Curve was prepared as per Roberts Copper Method. About 500 mg dextran were weighed and dissolved in water and diluted to 500 ml (the solution contains 1.0 mg of dextran/ml) and prepared solution was used for each standard curve determination. About 100 mls of a 1.0 mg dextran/mL standard solution was diluted to 1 L (0.1 mg dextran/ mL). This solution was used in aliquots of 20, 40, 60, 80 and 100 mL, each diluted to 100 mL to prepare standard curve. Each solution contains 0.02, 0.04, 0.06, 0.08 and 0.1 mg dextran/mL respectively. The data obtained was used to construct a calibration curve with concentration of dextran on the x-axis and the actual absorbance on the y-axis.

Phenol-H_2S0_4 Test.

Phenol-H_2S0_4 Test was done as per Roberts Copper Method. Ina series of six (6) test tubes, 2 ml of each dextran standard solution was placed and two (2) ml water in another test tube as a blank then 1ml of a 5% phenol solution was added to each tube. Tubes were swirled gently to mix phenol and carbohydrate solution. To each tube 10mls of Conc.H_2S0_4 was added preferably using plastic automatic pipet and acid released rapidly to ensure that solution was well mixed. Tubes was placed in rack and boiled in water bath for 2 minutes and then cooled for 30 minutes and corresponding absorbance was measured on a spectrophotometer at 485 nm against a blank solution.

Calculation

Dextran mg/ml, from standard calibration curve,

$$X, \frac{mg}{100ml} = (Y - C) * \frac{b}{M!} * V \text{.....5}$$

Where by,

X, mg/100g = Amount of dextran in mg/100ml.

Y = Actual absorbance read from spectrophotometer

C = y-intercept

M = Slope from standard curve

B = conversion factor to 100 ml

V = Volume of analytical sample analyzed.

Calculation

The colony forming unit of microorganism per ml (CFU/ml) for all fresh sugarcane juicesample was calculated using the following formula**: -**

$$CFU / g = \frac{\sum C}{V(n_1 + 0.1n2 + 0.01n3)d} \quad \text{.....6}$$

Where:

∑C is the sum of the CFU counted on all dishes retained from three successive dilutions.

n_1 is the number of dishes retained at the first dilution (n_1) =2

n_2 is the number of dishes retained at the second dilution (n_2) =2

n3 is the number of dishes retained at the third dilution (n_3) =2

V is the volume of inoculums in milliliters applied to each dish (V) =1

d is the dilution factor corresponding to the first dilution retained ($d=10^{-3}$)

Statistical data analysis

Data collected from laboratory were processed through coding and analyzed using the statistical software package for the social sciences (IBM SPSS version 25.2017)**..**

2. RESULT AND DISCUSSION

The Table 1 shows the result of the analysis of variance for different dependent variables that show significant differences in all variables.

Table 1: ANOVA Table of different dependent variables

Variables		Sum of Squares	Df	Mean Square	F	Sig.
CUF_BACT	Between Groups	458685163134.373	2	22934258 1567.186	107.503	.000
	Within Groups	185601683768.013	87	21333526 86.989		
	Total	644286846902.386	89			
CUF_YEAST	Between Groups	77284397658.151	2	38642198 829.076	755.976	.000
	Within Groups	4447058481.303	87	51115614. 728		
	Total	81731456139.454	89			
pH	Between Groups	1.887	2	.943	33.957	.000
	Within Groups	2.417	87	.028		

	Total	4.304	89			
BRIX	Between Groups	209.835	2	104.917	110.104	.000
	Within Groups	82.902	87	.953		
	Total	292.737	89			
POL	Between Groups	271.308	2	135.654	85.944	.000
	Within Groups	137.321	87	1.578		
	Total	408.629	89			
PURITY	Between Groups	498.320	2	249.160	11.774	.000
	Within Groups	1841.038	87	21.161		
	Total	2339.358	89			
WEIGHT	Between Groups	1333300.273	2	666650.136	140.211	.000
	Within Groups	413651.120	87	4754.611		
	Total	1746951.393	89			

Table 2 provide a description on multiple comparison of the effect of storage time as an independent variable with dependent variables. The table provide an overview by comparing each level of storage time with each other and their significance level. The result of multiple comparisons shows that for *Leuconostoc* bacteria count, yeast, pol, purity and weight there was no significant difference (P= 0.05) between 24 and 72 hours of storage time. The significant difference is noted between 24 to 120 and 72 to 120 hours of storage time. The result is contrary for brix and pH, indicating significant difference between all levels of storage time

Table 2 Description of multiple comparison on the effect of storage time

Dependent Variable	(I) Storage time	(J) Storage time	Mean Difference (I-J)	Std. Error	Sig.
CUF_BACT	24.00	72.00	-7794.59463	11925.74997	.791
		120.00	-155187.38747*	11925.74997	.000
	72.00	24.00	7794.59463	11925.74997	.791
		120.00	-147392.79283*	11925.74997	.000
	120.00	24.00	155187.38747*	11925.74997	.000
		72.00	147392.79283*	11925.74997	.000
CUF_YEAST	24.00	72.00	-3388.33947	1845.99774	.164
		120.00	-63787.72213*	1845.99774	.000
	72.00	24.00	3388.33947	1845.99774	.164
		120.00	-60399.38267*	1845.99774	.000
	120.00	24.00	63787.72213*	1845.99774	.000

		72.00	60399.38267*	1845.99774	.000
pH	24.00	72.00	.17667*	.04304	.000
		120.00	.35467*	.04304	.000
	72.00	24.00	-.17667*	.04304	.000
		120.00	.17800*	.04304	.000
	120.00	24.00	-.35467*	.04304	.000
		72.00	-.17800*	.04304	.000
BRIX	24.00	72.00	.83000*	.25204	.004
		120.00	3.57333*	.25204	.000
	72.00	24.00	-.83000*	.25204	.004
		120.00	2.74333*	.25204	.000
	120.00	24.00	-3.57333*	.25204	.000
		72.00	-2.74333*	.25204	.000
POL	24.00	72.00	.67333	.32439	.101
		120.00	3.97333*	.32439	.000
	72.00	24.00	-.67333	.32439	.101
		120.00	3.30000*	.32439	.000
	120.00	24.00	-3.97333*	.32439	.000
		72.00	-3.30000*	.32439	.000
PURITY	24.00	72.00	-.36333	1.18775	.950
		120.00	4.80000*	1.18775	.000
	72.00	24.00	.36333	1.18775	.950
		120.00	5.16333*	1.18775	.000
	120.00	24.00	-4.80000*	1.18775	.000
		72.00	-5.16333*	1.18775	.000
WEIGHT	24.00	72.00	41.38000	17.80376	.058
		120.00	276.38667*	17.80376	.000
	72.00	24.00	-41.38000	17.80376	.058
		120.00	235.00667*	17.80376	.000
	120.00	24.00	-276.38667*	17.80376	.000
		72.00	-235.00667*	17.80376	.000
Dextran	24.00	72.00	-199.36387*	43.31016	.000
		120.00	-485.07209*	43.31016	.000
	72.00	24.00	199.36387*	43.31016	.000
		120.00	-285.70823*	43.31016	.000
	120.00	24.00	485.07209*	43.31016	.000
		72.00	285.70823*	43.31016	.000

Table 3 provide descriptive information on the impact of storage time on pH, brix, pol, purity and weight(gram) of harvested burnt sugarcane juice. The result from descriptive table shows the general trend of pH, brix, purity and weight of harvested burned sugarcane over storage time under ambient environmental conditions. The result revealed that the meansvalues on all dependent variables were decreasing as storage increased, indicating deterioration of sugarcane. The pH, brix, pol, purity and weight mean values decreased with an increase in storage time from 24 hours after

harvesting to 120 hours. Adecrease in mean values of pH, brix, pol, purity and weight over storage time indicate that the composition of sugarcane starts to change after harvesting burnt sugarcane. The change in sugarcane composition has a negative impact on quality of sugarcane as the raw material for sugar production [11].

Table 3: Effect of time interval (storage time) on the pH, brix, pol, purity and weight of harvested of burnt sugarcane

Storage time (hours)	pH Mean±SD	Brix Mean±SD	Pol Mean±SD	Purity Mean±SD	Weight Mean±SD
24	5.48±0.14[a]	19.50±1.16[a]	17.36±1.51[a]	88.92±3.92[a]	691.51±79.05[a]
72	5.30±0.17[b]	18.67±0.99[b]	16.68±1.43[a]	89.28±5.69[a]	650.13±80.57[a]
120	5.13±0.17[c]	15.92±0.70[c]	13.38±0.62[b]	84.12±3.94[b]	415.12±38.99[b]

Values are means ± standard deviation of the mean of duplicate determinations. Values in the same column having the same superscripted letters are not significantly different (p > 0.05) according to Duncan Multiple Range Test

Table 4 provides descriptive information on the microbial aspect indicating the Impact of storage time on *Leuconostoc* bacteriaand Yeast determined from harvested burnt sugarcane. The result reveals that the meanvalues on *Leuconostoc* bacteriaand Yeast were increasing as storage increase

Table 4: Total *Leuconostocmesenteroides* count (CFU/g) and yeasts (CFU/g) burnt sugarcane and dextran

Storage time(hours)	*Leuconostocmesenteroides* count (CFU/g) Mean±SD	Yeast (CFU/g) Mean±SD	Dextran Mean±SD
24	7500.30±3990.85[b]	4755.82±2760.95[b]	135.19±90.16778[c]
72	15294.89±3207.96[b]	8144.16±2920.72[b]	334.56±141.23639[b]
120	162687.68±79836.33[a]	68543.54±11712.95[a]	620.27±237.34300[a]

Values are means ± standard deviation of the mean of duplicate determinations. Values in the same column having the same superscripted letters are not significantly different (P= 0.05) according to Duncan Multiple Range Test

Impact of storage time on pH of harvested burnt *S. officinarum*

The result shows a significant difference(P> 0.00) in the mean pH of harvested sugarcane.The gradual decrease in pH over storageperiodindicate increased acidity in the stored burnt sugarcane. A similar trend wasobserved by[27]who reported decrease in pH of sugarcane stored for 12 days under environmental condition. Moreover, an increase in acidity signifies biochemical changes or degradation in harvested sugarcane.The pH is regarded as quality parameter to monitorquality ofsugarcane[28].A drop in pH caused by organic acid, specifically lactic acid[29].. According to[22],observed that the acidity of sugarcane juice has a relationship with

the degradation characteristic of harvested sugarcane. A decrease in pH indicates the presence of a considerable number of acid-forming bacteria, which leads to the creation of lactic acetic acid. Moreover, it was described by[30], that bacteria as main

source of organic acid and lactic formation and comes from soil that contaminates sugarcane through the cut end, the development of these acid lead to decrease of pH and sucrose loss.

Impact of storage time on brix (total soluble solids) of harvested burnt *S. officinarum*

According to[31]sugarcane juice contains 20% total soluble solid (TSS). The dissolved solids include sucrose, glucose, fructose, and nitrogenous compounds in which sucrose contain higher proportion about 18%. The result shows that brix as a measure of total soluble solid decreased significantly as storage time increased.The brix mean with standard deviation values were 19.50 ± 1.16^{a} ,18.67 ± 0.99^{b} and 15.92 ± 0.70^{c} for 24,72 and 120 storage hours respectively. According SASTA, (2009) brix of sugarcane juice must be ranged between 18-23%. This indicate sugarcane stored for 120 hours is of range as compared to SASTA standard. The decrease brix values over storage time has been reported by [20]: [23] and [32]who reported a gradual drop in brix values with storage time This change in brix might be attributedby action of microorganisms that consume sugar in sugarcane during storage period. The decrease in brix indicates sugar deterioration is taking place due to delayed in processing harvested burnt sugarcane. The brix measure provides useful information to sugarcane growers and processor, that harvestedsugarcane need to be processed immediately between 24 to 72 hours after harvesting as their brix value are within SASTA standard, any delayin milling harvested burned sugarcane beyond 72 hours after harvesting results in a significant loss of brix, which is accounted as an economic loss to both producers and processors. According to[33] brix is measure usedto assesssucrose concentration and indicators of sucrose loss

Impact of storage time on pol value of harvested burnt sugarcane

Polarization (pol), quantifies the percent proportion of sucrose in sugarcane. The results show that the storage time interval has a significant influence on the pol as a measure of the quality of burnt sugarcane. The mean values for pol were 17.36 ± 1.51^{a},16.68 ± 1.43^{a} and 13.38 ± 0.62^{b} for 24,72 and 120 storage hours respectively According to SASTA[34]the pol values should range from 14 – 21%. From this standard the pol values for 24 and 72 storage time are within recommended standard where 120 storage hoursare beyond specification. The120-storage timecontribute to greater extent ofdeterioration, which is a significant challenge for sugarcane growers and the sugar industry. Looking on mean pol trend, there was decrease in pol with increase in storage timeThe results are in line with[35], who reported that prolonging the period between harvesting and crushing greatly decreases the sucrose content percent. Similarly,[36] and [37],reported that the proportion of sucrose decreases as the post-harvest time increases. Studies done by [1], [38], and [9], have explained the courses on sucrose decline throughout storage time and documented how microorganisms, chemical reactions, and enzyme activity as the main courses.

Impact of storage time on purity of harvested burnt sugarcane

The percentage of sucrose included in the total soluble solids content of the juice is referred to as its purity. A higher purity suggests a higher sucrose concentration of the total soluble solids contained in the sugarcane juice. A solution's purity is defined as the percentage ratio of pol to brix insugarcane the samples. Basedon the result, the mean purity at 24 storage time was 88.92%, and it remained fairly steady at 89.28% at 72 indicating no significance difference between the two-storage time. However, there was a significant decline in purity to 84.12% after 120 hours, which might indicate a deterioration in sugarcane quality due to enough storage time. The data indicates a mean purity of 87.44% across the storage time, indicating that overall sugarcane purity is still satisfactory as compared to specification recommended by SASTA, (2009) that the Purity % of sugar cane must be ranged between 77 – 93.5 %. The purity mean value was not significant difference according to the analysis of variance results. Despite a slight drop in purity%, the difference is insignificant. This might be due to the mathematical computation required in obtaining purity.

Impact of storage time on weight of harvested burnt sugarcane

The ANOVA table (Table .1) findings show that the weight loss during the given storage duration was significant difference (*P*=0.05) across the storage time.The result reveal that the mean values for weight decreased as storage duration increased. The mean values for weight dropped from 691.51±79.05 to415.12±38.99 grams. The result was in agreement with [16]who described the decrease in weight of harvested burnt sugarcane over storage time. The weight loss could be due to moisture loss in juice content over time. It was reported by [29], that losses in weight of harvested sugarcane caused by increase in rate of respiration Moreover, according to[39]preharvest burning ofsugarcane causes horizontal cracking along sugarcane stalkthat lead to loss of moisture content. In addition, it observed by [40]that harvestedsugarcane experiences moisture loss, that reduce weight of sugarcane According to [41]study, weight loss began immediately 24 hours after harvesting andincrease with storage duration caused bymoisture loss due to evaporation as well as increased respiration. The major function of sugarcane weight is to tell sugar companies and growers about how successfully the plant was managed prior to harvesting. On the other hand, well-managed sugarcane will have a large weight compared to less-managed sugarcane**Microbial infestation**

Sugarcane is a crop that provide good environment for microbial growth as it contains around 15-18% sucrose,0.5% reducing sugar and sufficient amount of organic nitrogen and mineral salt with pH 5.0 to 5.5 allowing mostly acidophilic organism particularlylactic acid bacteria and yeast [42].According to[6], reportedthat green sugarcanecontainsminimal number of microorganisms as compared to burnt harvested sugarcane that allow easily invasion and multiplication of microbial growth that led into conversion of sucrose into nonsugar and polysaccharide compounds

Yeast

Result shows that yeast population increased with increase in storage time (Table.4). The mean value for yeast population increased from4755.82±2760.95 to 68543.54±11712.95 Cfu's.The result indicate that the increase in yeast population was significant. According to[43], presence of yeast in sugarcane play role in

converting sucrose into non sugar byproduct (ethanol and carbon dioxide) thereby contributing to postharvest sucrose losses

***Leuconostoc* bacteria**

Contamination of sugarcane with *Leuconostoc*bacteria occurs during harvesting through cross contamination with cane cutters machete and soil. The bacteria enterthe internal part of sugarcane stalk and reproduce. The results showthat number*Leuconostoc*bacteria (cfu) increased from 24 to 72 hours of storage and highest level was noticed in 120 hours of storage.The mean values for *Leuconostoc* bacteria count were7500.30±3990.85,15294.89±3207.96 and162687.68±79836.33 Cfu's for 24,72 and 120 hour of storage respectively.The presence and increase in microbial proliferation isevident that deterioration of sugarcane is taking losses. Similarly, [44] reported that entrance *Leuconostoc*spp into sugarcane juice allow to grow, multiply and consume sugar

Dextran

Result (in Tab No.4) shows that amount of formed dextran (mg/kg) varied and increased across the storage time. Theconcertationincreased from 24 to 72 and highest level was observed in 120 hours of storageThe means values in 24, 72, and 120 hours were 135.19±90.16778[c], 334.56±141.23639[b]and 620.27±237.34300[a]mg/kg respectively. The formation of dextran in stored sugarcane provide evidence that microbial activity is taking place essentially *Leuconostoc*spp which consume sucrose leading to sucrose loss. Dextran has been reported by several studies that its formation indicatespostharvest deterioration of sugarcane[45]:[46]

According to [47] high level of dextran(>150 mg/kg) cause a serious problem as recommended by South African Sugar Terminals (SAST) that maximum requirement for dextran is 150 mg/kg. Comparing result with this recommendation, show that dextran content found in 72 and 120 storage hours was greater than 150 mg/kg. Based on these results and dextran as indicator of deterioration, it shows greater post-harvestsucrose losses due to burn to crush (burn to mill) delay. Furthermore[42],pointed out that for each 0.1 percent of dextran being formed represent 0.04 percent sucrose loss

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3. Conclusion

The results revealthat purityvalues were satisfactory in all storage time levels as compared to SASTA standard, whereas brix and pol were affected negatively by 120 hours of storage.as compared to SASTA standard and dextran level as the measure of microbial deterioration was high in 72 and 120 storage hours as compared to given reference. These finding suggest that storage time of 120 hours affect mostly the quality of sugarcane as a raw material for sugar manufacturing. The harvested sugarcaneneeds to be processed between 24 and 72 hours after harvesteing.to reduce postharvest sucrose losses. Apart from time interval from harvest to mill, preharvest-burning of sugarcane is noted as the factor that create friendly environment for quality deterioration to occur as it courses damage of wax that provide protective layer on sugarcane stalk and bursting of protective external layer of sugarcane stalk leading to easily moisture loss and access by microorganism

Therefore, it is recommended that farmers and processors should be properly informed about the consequence of delayed processing burned sugarcane to avoid economic loss and be informed that minimum burn to crush/mill interval time should not exceed 72 hours, this is important to ensure minimal postharvest sucrose losses. and finally,a joint effort that will ensure timely harvesting, transportation and milling are necessary between the investor (sugarcane processor), sugarcane cooperatives (representing farmers), and Tanzania Sugar Board to bridge the gap from harvest to mill by examining the underlying causes and creating regulations that can be used to address issues such as poor infrastructure, burning, and poor truck condition that demand regular service. Poor infrastructure. preharvest burning and poor truck condition are among the major issues. increasing post-harvest losses

ACKNOWLEDGEMENT

The authors are grateful for the financial support provided by Ministry of Agriculture, Tanzania

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