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JUICE AND JAGGERY QUALITY PARAMETRES AS AFFECTED BY ADVERSE SUGARCANE PRODUCTION CONDITIONS

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ABSTRACT

Good quality sugarcane juice is a prerequisite for obtaining quality jaggery. The good quality parametres of sugarcane juice enhances the shelf life of jaggery also. An experiment conducted at Zonal Agricultural Research Station, V.C. Farm, Mandya has revealed that lodged cane recorded lowest juice brix (18.08%), lower juice purity (84.11%) and CCS percentage (10.81%) in saline soil. Accumulation of phenols in juice was higher in saline conditions (62.51 µg ml-1) compared to normal soils (56.67 µg ml-1). The higher ash content of 0.50 per cent was recorded in cane juice from lodged condition. Higher cane weight, juice weight, juice extraction and jaggery yield were recorded in cane from normal soils compared to adverse sugarcane production conditions.

INTRODUCTION

Sugarcane (Saccharum spp. complex hybrid) is one of the important commercial crops of the world. Modern sugarcane varieties are complex hybrids derived largely from the interspecific crosses involving *Saccharum officinarum* L. (2n = 80) and the wild species *S. spontaneum* L. (2n =40-128) (Srivastava and Gupta 2008). Sugarcane, a crop of great worldwide economic importance accounts for approximately 75 per cent of the global sugar production (Commodity Research Bureau 2015). Being a C4 plant with a long-life cycle, it utilizes high amount of water, nutrients, CO_2 and solar energy to produce Sugarcane is one of the most important agro-industrial crops in our country. Sugarcane is the raw material for producing three products viz. Sugar, Jaggery and Khandsari. Sugarcane is a renewable natural agricultural resource. The byproducts of sugar industry are bagasse and molasses and bagasse is largely used as fuel. Bagasse is also utilized for production of compressed paper, plastics and fiber board. Molasses is used in distilleries for the production of ethyl alcohol, butyl alcohol, citric acid etc. Sugarcane is

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Cultivated in an area of about 4.0 lakh hectares in Karnataka with 42 million tonnes of cane production. It is an important commercial crop in southern Karnataka cultivated mainly in Cauvery and Bhadra Command areas, which covers an area of about 1.5 lakh hectares. Apart from obtaining sugar from sugarcane, it is also used for preparation of jaggery. In Cauvery Command area alone 4.3 m t of canes is produced and more than 35-40 per cent of this goes for jaggery production (Anon, 2002a). Jaggery making is entirely a domestic cottage industry in rural areas fetching better income to sugarcane growers and helps in upliftment of their standards of living wherever sugar industry is in crisis.

By virtue of it having all the ingredients of sugarcane juice intact, jaggery is a better sweetener than sugar which contains only sucrose. Hence, nutritionally and from the part of view of its use in ayurvedic preparation, jaggery is a sweetener as sugar is seldom used in ayurvedic preparations.

Jaggery is an important sweetening agent apart from sugar. The quality of sugarcane juice determines the quality of jaggery. Jaggery is a traditional unrefined non–centrifugal sugar consumed in Asia, Africa, Latin America and Caribbean.

Nutritional value of jaggery

The acceptable taste and nutritive value of jaggery has attracted man since ancient times. Jaggery is also called “Non centrifugal sugar” or Artisan sugar. It forms an important item of Indian diet for its high nutritive value and as a sweetening agent. White sugar contains only sucrose (99.70%), whereas jaggery has sucrose (65-85 %), protein (0.25%), glucose (21.20%) and minerals (3.40%) in addition to traces of fats (0.02 to 0.03%), calcium (0.39%), vitamin A, vitamin B, Phosphate

(0.025%) and provides 383 K cal/100g jaggery (Shrilakshmi, 2003).

Dietary sucrose (sugar) is a mixed blessings which makes food more attractive and appetizing but excessive consumption often leads to several kinds of pathological conditions like coronary thrombosis, heart disease, diabetes, acidity, depression and obesity etc., Numerous studies have also revealed that high sugar consumption leads to higher cancer risk. Jaggery which is an alternative sweetener from sugarcane is considered health friendly. In Ayurveda, jaggery is considered to be the best of all the sugarcane preparations (Shrilakshmi, 2003).

As sugarcane is a versatile crop in the command area, since inception of irrigation projects, many adverse conditions have been thrown against it to be able to survive. The area under saline and alkaline conditions have been on the rise due to faulty irrigation methods adopted. This has led to a greater challenging task of rising the crop under these conditions. In addition, recent drought and moisture stress conditions have made the problem even more tough for the crop. However, under adverse conditions also, sugarcane is being cultivated. Hence, the present investigation was take up for characterization of sugarcane juice qualities with the objective to characterize the sugarcane juice from the sugarcane grown in adverse sugarcane production conditions.

METHODOLOGY

Sugarcane samples were drawn from the five adverse sugarcane growing conditions in addition to sugarcane from normal soil in farmer's field and research station condition. This was done after assessing the soil conditions to classify the soils as adverse production conditions accordingly. Following are the villages from which these conditions were identified and samples drawn for the study. The villages were viz., Basavanapura, Bandur and Dadadapura villages of Malavalli taluk of Mandya district which had the adverse sugarcane production conditions like saline soil, sodic soil, lodged cane, shaded area and moisture stress conditions.

Assessment of adverse conditions

Adverse cane production conditions viz., saline soils, sodic soils, lodged cane, shaded area, moisture stress in comparison with normal soil were assessed based on the sampling of soils from the fields with purposive sampling method. These adverse conditions of soil were characterized by analyzing pH, EC, ESP of soil as per the standard procedure for assessing the adverse production conditions of normal, saline and sodic soils. The conditions like lodged cane and shaded area were assessed by making field observations. Moisture stress condition was assessed by rainfall during the crop season, irrigation given to the crop and also by assessing crop stand with field observations.

Table 1: Initial soil properties of sugarcane fields of adverse conditions.

Sl. No	Soil conditions	pH $_{1:2.5}$	EC $_{1:2.5}$(dS m^{-1})	ESP (%)
1.	Normal soil from farmer's field	7.1	0.96	7.40
2.	Normal soil from research station	7.3	1.04	9.70
3.	Saline soil	8.2	1.5	10.80
4.	Sodic soil	8.7	0.85	32.0
5.	Lodged cane	7.7	0.87	7.23
6.	Shaded area	7.9	0.78	7.40
7.	Moisture stress	8.1	0.32	11.20

3 Collection of samples

From the assessment of conditions and fixing the field for sampling each sampling, field was divided into three clusters of equal population but uneven in area. From these clusters twenty fully matured (12 months old) sugarcanes were sampled at random. From each cluster observations were recorded and used for characterization of quality parameters.

Number of clusters: 3

Number of conditions: 7

Population size: 20 canes from each replication.

Juice extraction per cent

The juice extraction per cent was calculated on weight-by-weight basis by following formula.

$$\text{Juice extraction (\%)} = \frac{\text{Juice weight}}{\text{Weight of cane}} \times 100$$

Jaggery yield (t ha^{-1})

Jaggery yield was estimated by using the following formula,

$$\text{Jaggery yield (t ha}^{-1}\text{)} = \frac{\text{Cane yield (t ha}^{-1}\text{)} \times \text{Jaggery recovery per cent}}{100}$$

Jaggery recovery percent

It was calculated by the following formula

$$\text{Jaggery recovery (\%)} = \frac{\text{Weight of jaggery obtained} \times \text{Total weight of juice}}{\text{Wt.of juice used for jaggery preparation} \times \text{Wt.of cane}} \times 100$$

Jaggery quality parameters

Colour

Jaggery prepared in the laboratory was classified into different categories of colour based on visual observation and optical density. Light or golden coloured jaggery was not only attractive but also purer than the dark coloured and it was preferred by the consumers. The colour intensity of the 0.5 N solution of Jaggery (13g/100ml) was measured in a photoelectric colorimeter using a blue filter (420 nm) and the colour intensities were expressed in absorbance.

Moisture content

A sample of 20 g of jaggery was taken and dried in oven at 80^0 C for 3-4 hours. Then the dried samples were weighed and this value was subtracted from the fresh weight of the sample to obtain moisture per cent in jaggery.

$$\text{Moisture \%} = \frac{\text{Wt.of fresh sample (g)} - \text{Wt.of sample after drying (g)}}{\text{Wt.of sample after drying (g)}} \times 100$$

Determination of sucrose percent

The sucrose content in the jaggery was determined by polarimetre by clarifying a 0.5 N solution of jaggery (32.5 g in 250 ml of water) with addition of 3 g of lead sub acetate. It was shaken, kept it for 30 min-1hour until supernatant was attained. The supernatant was filtered with Whatmann filter paper. Then the filtrate was transferred to a 200 mm pol tube with exclusion of air bubbles. The pol reading was taken using the Polarimeter. The pol reading recorded was correlated with the observed degrees 'Brix' with the help of "Schmitzs table" to get values of pol per cent of jaggery which is synonymously used for sucrose percent in jaggery.

Determination of reducing sugars

The reducing sugar was estimated by titrating the jaggery solution (13 g of jaggery in 100 ml water with 10ml of fehlings A+B solution + 10 ml Distilled water) against Fehling solution.

The samples containing reducing sugar precipitate and appear brick red in colour. And the total amount of reducing sugars was quantified by using the formula.

$$\text{Reducing sugars percent} = \frac{0.05 \text{ X Volume of jaggery solution}}{\text{Titer value x Weight of Jaggery}} \times 100$$

Phenol content

The total phenol content of jaggery was determined spectro photometrically using Folin-Ciocalteu's method. A sample aliquot of 100 µL (5%) was added to 900 µL of water, 1 ml of 0.2 N Folin-Ciocalteu reagent and 2 ml of 10% sodium carbonate sequentially, mixed and incubated for one hour at room temperature. The absorbance was measured at 765 nm in visible spectrophotometer (Systronics India Ltd. Gujarat, India). Gallic acid was used as standard and the total phenolic content expressed as micrograms of gallic acid equivalent (GAE) per gram of sample.

RESULTS AND DISCUSSION

Brix (%)

The brix per cent, purity per cent and CCS per cent of sugarcane juice in adverse production conditions are provided in Table-2.

The Brix per cent did vary in cane juice from normal production conditions over other adverse production conditions. The higher brix per cent was recorded in cane of moisture stress condition (21.31 %), normal soil condition on farmer's field (20.14 %) and normal soil condition on research station (20.01 %) which were on par with each other and significantly superior over the cane of lodged condition (18.08 %).

Purity (%)

The purity was significantly differed when cane juice was analyzed from cane of normal soil and adverse condition. The higher purity per cent was noticed in the cane of normal soil on farmer's field (91.79 %) followed by normal soil condition on research station (91.71 %) which was significantly superior over the cane of saline soil (84.14 %) and cane of sodic soil (84.11 %) conditions.

CCS (%)

The CCS per cent was significantly influenced by the sugarcane production conditions. The higher commercial cane sugar per cent of 13.53 was computed in cane from moisture stress condition followed by normal soil condition of farmer's field (13.02 %) and normal soil condition research station (12.91 %) were on par with each other. The lowest CCS per cent was noticed in cane of saline soil condition (10.81 %).

Higher purity, CCS (%) and brix (%) recorded in normal soil conditions have been reported by Begum *et al.* (2012), Choudary *et al.* (2004), Gomathi *et al.* (2005), yang (1979), Ghaffar *et al.* (2013), Mishra *et al.* (2016) and Anon, (1971). However, Wagh *et al*. (2004) reported that higher brix reading was observed under moisture stress condition. This might be due to more total solids present in the juice under moisture stress condition but the commercial cane sugar per cent was more under normal irrigation.

Table 2: Characterization of sugarcane juice Brix (%), Purity (%) and CCS (%) under adverse sugarcane production conditions.

Conditions	Brix (%)	Purity (%)	CCS (%)
C_1: Normal soil from farmer's field	20.14	91.79	13.02
C_2: Normal soil from research station	20.01	91.71	12.91
C_3: Saline soil	19.04	84.14	10.81
C_4: Sodic soil	19.69	84.11	11.17
C_5: Lodged sugarcane	18.08	89.80	11.32
C_6: Shaded area	19.02	88.14	11.59
C_7: Moisture stress	21.31	90.72	13.53
S.Em±	0.49	1.93	0.37
CD @ 5%	1.50	5.94	1.13

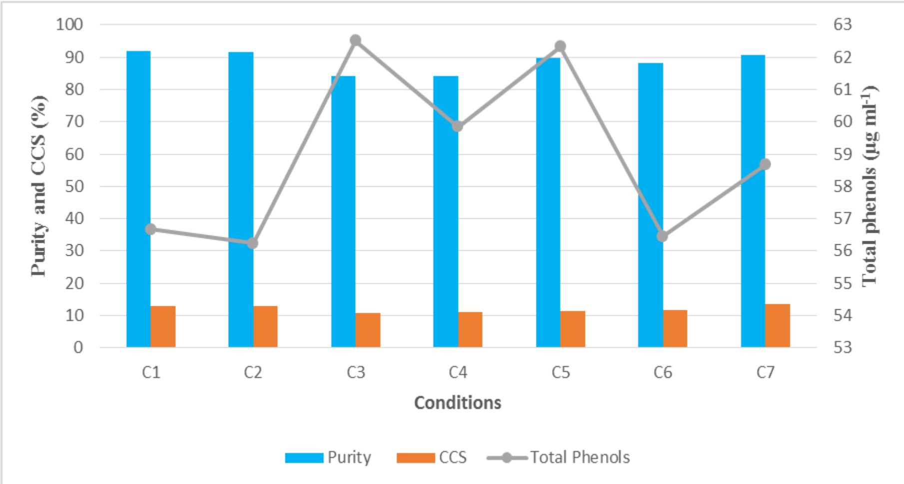

Fig. 1: Characterization of purity and CCS of sugarcane juice under adverse sugarcane production conditions.

Total phenols (µg ml^{-1})

The total phenol and ash content of sugarcane juice in adverse production conditions are represented in Table-3& figure 1. The total phenol content of sugarcane juice differed significantly in cane juice from normal soil production conditions over adverse production conditions. Higher phenol content of 62.51 µg ml^{-1}was recorded in cane of saline soil condition which was on par with cane of lodged condition (62.32 µg ml^{-1}) which were significantly higher over with cane of shaded condition (56.45 µg ml^{-1}). The sugarcane juice from normal soil conditions of research station and farmer's field (56.67 µg ml^{-1} and 56.23 µg ml^{-1} respectively) recorded significantly lower phenol content.

Ash (%)

Ash per cent in cane juice was significantly differed with different production conditions. The higher ash content of 0.50 per cent was recorded in cane juice from lodged condition which was on par with cane of saline soil condition (0.49 %) which was significantly higher than cane of shaded area (0.47 %) and sodic soil (0.43 %) condition which were on par to each other. The lowest ash content was noticed in normal soil condition on research station (0.33 %) and cane of normal soil from farmer's field (0.31 %) conditions.

Gupta *et al.* (1967) from their experiment on study of factors affecting ash content in juice have revealed the significant increase in ash content of the juice in the drought conditions compared to irrigated condition due to more fibre content. Similar findings have also been reported by Singh *et al*. (1980).

Table 3: Characterization of sugarcane juice total phenols and ash (%) under adverse sugarcane production conditions.

Conditions	Total phenols (µg ml^{-1})	Ash (%)
C_1: Normal soil from farmer's field	56.67	0.33
C_2: Normal soil from research station	56.23	0.31
C_3: Saline soil	62.51	0.49
C_4: Sodic soil	59.84	0.43
C_5: Lodged sugarcane	62.32	0.50
C_6: Shaded area	56.45	0.47
C_7: Moisture stress	58.67	0.40
S.Em±	1.52	0.01
CD @ 5%	4.68	0.03

Jaggery yield parameters

Jaggery yield parameters *viz.* cane weight, juice weight, juice extraction per cent and jaggery recovery per cent in adverse sugarcane production conditions are presented in Table-4 & figure 2.

Cane weight

Sugarcane weight significantly differed among the cane production conditions among the cane weight of sample 20 canes. The higher cane weight was noticed in cane of normal soil condition on farmer's field (33.62 kg) followed by cane of normal soil on research station (33.21 kg) condition which was significantly superior over with the cane of lodged cane (25.12 kg) and cane of saline soil (25.01 kg) conditions. The lowest cane weight was noticed in cane of moisture stress (18.43 kg) condition.

Juice weight

Juice weight after extraction from cane did differ significantly with sugarcane production conditions. The higher juice weight was recorded in normal soil condition on research station (22.76 kg) followed by normal soil condition on farmer's field (21.75 kg) conditions which were significantly superior over with cane of saline soil (14.51 kg) and cane of shaded condition (14.47 kg) and lodged cane (11.78 kg) condition. The lowest juice weight was recorded in cane of moisture stress (7.6 kg) condition.

Juice extraction per cent

Similar trend was noticed in juice extraction per cent. Cane of normal soil was significantly different over other production conditions. The higher juice extraction per cent of 68.69 per cent was recorded in normal soil condition on research station and normal soil condition on farmer's field (64.68 %) condition which were on par with cane of shaded condition (58.95 %) and cane of saline soil (58.15%) conditions. The lowest juice extraction per cent was recorded in cane of moisture stress (41.23 %) condition.

Jaggery yield

Jaggery yield was significantly different with cane from normal soils over adverse production conditions. Higher jaggery yield was recorded in normal soil condition on farmer's field (19.37 t ha^{-1}) and normal soil condition on research station (19.02 t ha^{-1}) conditions which were on par with each other and superior over cane of saline soil (15.42 t ha^{-1}) and cane of sodic soil (14.89 t ha^{-1}) conditions. The lowest jaggery yield recorded in cane of moisture stress (9.05 t ha^{-1}) condition.

Jaggery recovery per cent

Jaggery recovery per cent was significantly influenced by the conditions of cane growth. The higher value of 11.60 per cent recorded in normal soil condition on farmer's field followed by normal soil condition on research station (11.32 %) which were on par with each other followed by cane from lodged condition (10.12%) and cane of saline soil (9.88%) conditions which was significantly superior over cane from moisture stress (6.85 %) condition.

The higher jaggery yield parameters like cane weight, juice weight, juice extraction per cent and jaggery recovery per cent was noticed in normal soil conditions. These findings are in conformity with Misra *et al.* (2016), Hadi (1929), Jambulingam *et al.* (2001) and hart (1936) as represented by that Jaggery recovery from unit weight of cane depends on the juice sucrose content and the volume of juice extracted. However, the juice volume is dependent on the fibre per cent of the cane and total cane output. This is the main reason for increased jaggery recovery as well as jaggery yield. Jadhav *et al*. (1988) have stated that more of non-sugars constituents in juice adversely affect the settling rate by increasing mud volume. Hadi (1929) and Hartt (1936) have also reported that sugarcane grown under drought condition had poor extraction of juice.

Table 4: Characterization of Jaggery yield parameters under adverse sugarcane production conditions.

Conditions	Cane weight (kg)	Juice weight (kg)	Juice extraction (%)	Jaggery yield (t ha^{-1})	Jaggery recovery (%)
C_1: Normal soil from farmer's field	33.62	21.75	64.68	19.37	11.60
C_2: Normal soil from research station	33.21	22.76	68.69	19.02	11.32
C_3: Saline soil	25.01	14.51	58.15	15.42	9.88
C_4: Sodic soil	24.64	12.53	50.47	14.89	9.67
C_5: Lodged sugarcane	25.12	11.78	46.89	14.26	10.12
C_6: Shaded area	24.58	14.47	58.95	14.22	9.35
C_7: Moisture stress	18.43	7.60	41.23	9.05	6.85
S.Em±	0.89	0.71	3.29	0.36	0.50
CD @ 5%	2.73	2.18	10.14	1.10	1.53

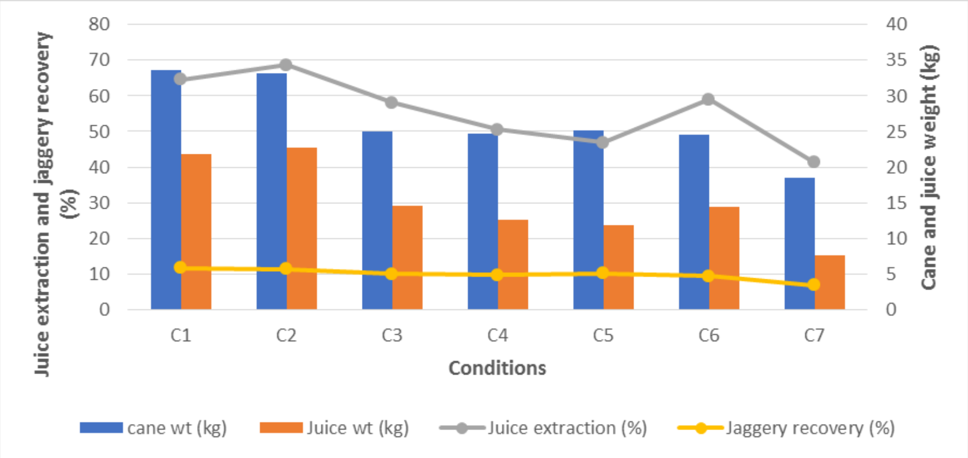

Fig. 2: Characterization of cane weight and juice weight under adverse sugarcane production conditions.

Colour

Data on jaggery quality parameters viz., colour, texture and taste in adverse sugarcane production conditions are presented in Table-5 & figure 3.

Colour of jaggery was significantly influenced by the conditions of sugaracne production. The higher OD value of 0.91 was recorded in cane of normal soil on research station followed by cane of normal soil on farmer's field (0.89) conditions which were on par and were significantly superior over with cane of moisture stress condition (0.58) followed by cane of sodic soil (0.52) conditions. The lowest OD value is recorded in cane from both saline soil and lodged conditions (0.47). These results are in line with the findings of Vasantha *et al.* (2009) where sugarcane grown under saline soil produce jaggery with poor grade, colour and taste since the juice quality characters were affected.

Color is an important physical parameter of jaggery as the dark color is disliked (Hussain et al., 2007). The most anticipated accepted colour is golden yellow colour of jaggery. The OD value has direct correlation with of the color of the jaggery, higher the OD value higher will be the color and vice versa. In this study, OD value was recorded upto a maximum of 0.91 in normal soil condition followed by moisture stress condition. Similar trend was also seen for a moisture stress condition in a study conducted by Uppal (2002). However, more of humic substances, total phenolics and higher moisture content will deteriorate the jaggery quality by darkening the color and amorphous in texture (Manohar *et al.*, 2014).

Although the normal soil and moisture stress conditions had higher sucrose content in jaggery and juice and had higher porosity in jaggery, the jaggery texture and taste was crystalline and very sweet in taste respectively, and was recorded as 'good' and 'medium' quality. Similar results were reported by Lakshmikantham (1973) and Uppal (2005) in their studies.

Texture and Taste

Texture is an important factor for determining the quality of jaggery. The texture may be crystalline or amorphous. The process of moisture absorption and inversion is accompanied by gradual fermentation, which imparts unpleasant taste and smell to the jaggery and because of this, texture is adversely affected. Such jaggery loses its crystalline nature and becomes soft and sticky. In this study, cane of normal soil on farmer's field and cane of normal soil on research station and cane of moisture stress condition showed crystalline texture with very sweet in taste due to higher porosity and higher sucrose with low moisture content of jaggery and cane of saline soil and lodged conditions showed amorphous texture with salty taste. These line are conformity with the findings of Jabbar (1983) where taste would be influenced by mineral salt, dirt etc.

Table 5: Characterization of jaggery colour, texture and taste under adverse sugarcane production conditions.

Conditions	Colour (OD value)	Texture	Taste
C_1: Normal soil from farmer's field	0.89	Crystalline	Very sweet
C_2: Normal soil from research station	0.91	Crystalline	Very sweet
C_3: Saline soil	0.47	Amorphous	Salty
C_4: Sodic soil	0.52	Amorphous	Sweet
C_5: Lodged sugarcane	0.47	Amorphous	Sour salty
C_6: Shaded area	0.78	Amorphous	Sweet
C_7: Moisture stress	0.58	Crystalline	Very sweet
S.Em±	0.03		
CD @ 5%	0.09		

Jaggery quality parameters

Hardness

Data on hardness, moisture per cent and porosity of jaggery in adverse sugarcane production conditions are presented in Table-9.

Moisture

Moisture per cent was influenced significantly with the conditions of sugarcane production. Higher moisture per cent was of 4.05 per cent recorded in cane of saline soil condition which was significantly higher than lodged cane condition (3.95%) and cane of moisture stress (2.98 %) conditions. The lowest moisture per cent was recorded in normal soil conditions of research station and farmer's field (2.07% and 2.65% respectively) conditions.

Porosity

The porosity of jaggery was significantly influenced by the conditions of cane production. The higher porosity was recorded in cane of normal soil on farmer's field (15.65 cc g^{-1}) followed by cane of normal soil on research station (15.38 cc g^{-1}) and moisture stress condition (14.42 cc g^{-1}) conditions which were significantly superior over with cane of saline soil (8.42 cc/g) followed by shaded area (7.32 cc g^{-1}) and sodic soil (6.21 cc g^{-1}) conditions. The lowest porosity was recorded in lodged cane (3.39 cc g^{-1}) condition.

Higher moisture content of jaggery was noticed in cane from saline soil condition which might be due to more quantity of water absorbed by jaggery samples due to inversion of sugars and more salt content. However, these findings are in line with the findings of Patil *et al.* (1994) where higher reducing sugars resulting in higher hygroscopicity of jaggery affecting the keeping quality adversely.

Jabbar (1983) found that hardness of jaggery is dependent on moisture content. Higher the moisture content, lowest will be the hardness. The moisture content is the most important constituent of jaggery which decides the hardness thereby shelf life of the jaggery (Arun *et al.* 2012). Higher the moisture content faster deterioration of jaggery quality by the darkening the jaggery and boosting microbial growth. Higher reducing sugars and mineral contents are the main cause for moisture absorption, hence they reduce the quality. In the present study in most of the conditions were in the range of 5-8 per cent which is nearer to standard requirement of 3-7 per cent scale as per Bureau of Indian Standards (ANON, 1990). These observations are in line with Singh *et al.* (1977). Uppal *et al.* (2005) who also reported similar pattern of moisture content of jaggery.

Table 5: Characterization of hardness, moisture content and porosity of jaggery under adverse sugarcane production conditions.

Conditions	Hardness (Kg cm^{-2})	Moisture (%)	Porosity (cc g^{-1})
C_1: Normal soil from farmer's field	3.08	2.65	15.65
C_2: Normal soil from research station	3.02	2.07	15.38
C_3: Saline soil	2.59	4.05	8.42
C_4: Sodic soil	2.30	2.71	6.21
C_5: Lodged sugarcane	1.00	3.95	3.39
C_6: Shaded area	2.70	2.48	7.32
C_7: Moisture stress	2.13	2.98	14.42
S.Em±	0.06	0.06	0.19
CD @ 5%	0.19	0.19	0.58

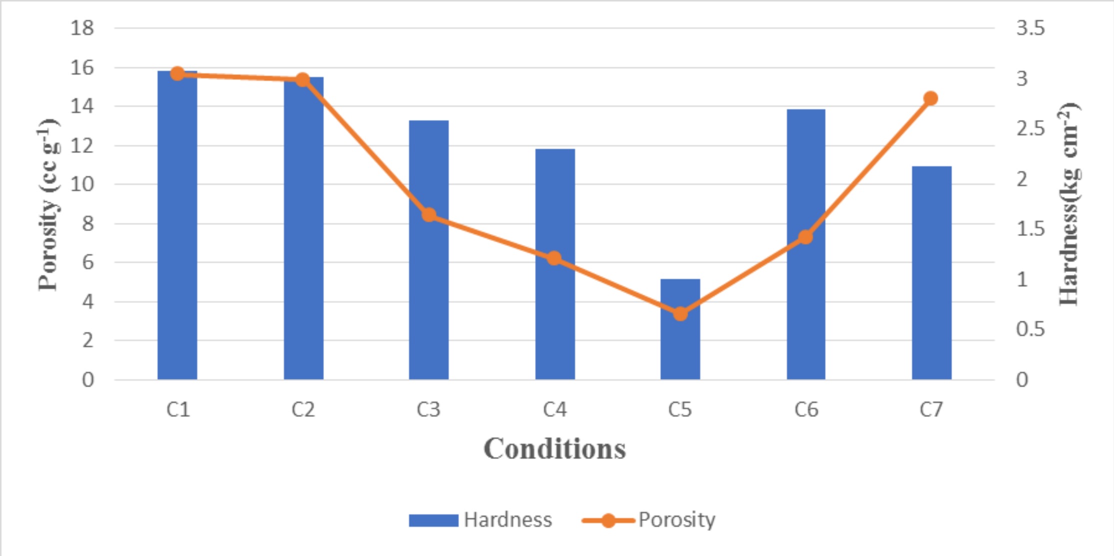

Fig 3: Characterization of hardness and porosity in jaggery under adverse sugarcane production conditions.

Brix (%)

Data on Brix, reducing sugar and sucrose per cent of jaggery in adverse production conditions are provided in Table-6 & figure 4.

Brix differed significantly under various sugarcane production conditions. The higher brix content of 11.90 per cent was observed in cane of normal soil on research station and cane of normal soil on farmer's field (11.70 %) conditions which was significantly superior over with cane of sodic soil (10.85 %) followed by cane of shaded area (10.68 %), cane of saline soil (10.28 %) conditions. The lowest brix content was observed in cane of lodged area conditions (10.17 %).

Reducing sugar (%)

Reducing sugar was significantly influenced by production conditions of sugarcane. The higher reducing sugar content of 7.39 per cent was recorded in cane of saline soil condition followed by lodged condition (7.29 %) which was significantly superior over with cane of shaded area (5.27 %) followed by cane of saline soil (5.03 %). The lowest reducing sugar was recorded in cane of moisture stress condition (3.27 %) followed by cane of normal soil on farmer's field and research station (3.36 % and 3.86 % respectively).

Sucrose (%)

Sucrose per cent was significantly influenced by sugarcane production conditions. The higher sucrose content of 74.15 per cent was observed in cane of normal soil on farmer's field followed by cane of normal soil on research station (73.38 %) and cane of moisture stress condition (73.77 %) conditions which were on par with each other and were significantly superior over with cane of shaded area (66.17 %) followed by sodic soil (63.03 %) and cane of lodged (60.79 %) conditions. The lowest brix content was observed in cane of saline soil (55.85 %) condition.

There was no difference in brix per cent of normal and moisture stress conditions. The reduction in juice brix and sucrose percent juice and jaggery has been reported by number of workers under salt stress conditions (Thomas *et al.*, 1981; Sharma *et al.*, 1997 and Muniaswamy, 1998).

Lowest sucrose content was recorded in saline and sodic soil conditions which might be due to reduction of enzyme involved in sucrose synthesis (SPS) and transport (SS, AI and NI), poor partitioning of sugars from source to sink (stem) under salinity conditions and excess accumulation of soluble toxic ions in stem and juice. Similar reduction pattern in sucrose per cent was reported by Sharma *et al.*, (1997) and Muniswamy (1998).

Table 6: Characterization of Brix, Reducing sugar and sucrose content of jaggery under adverse sugarcane production conditions.

Conditions	Brix (%)	Reducing sugar (%)	Sucrose (%)
C_1: Normal soil from farmer's field	11.70	3.36	74.15
C_2: Normal soil from research station	11.90	3.86	73.38
C_3: Saline soil	10.28	7.39	55.85
C_4: Sodic soil	10.85	5.03	63.03
C_5: Lodged sugarcane	10.17	7.29	60.79

C_6: Shaded area	10.68	5.27	66.17
C_7: Moisture stress	11.43	3.27	73.77
S.Em±	0.27	0.15	1.35
CD @ 5%	0.82	0.47	4.16

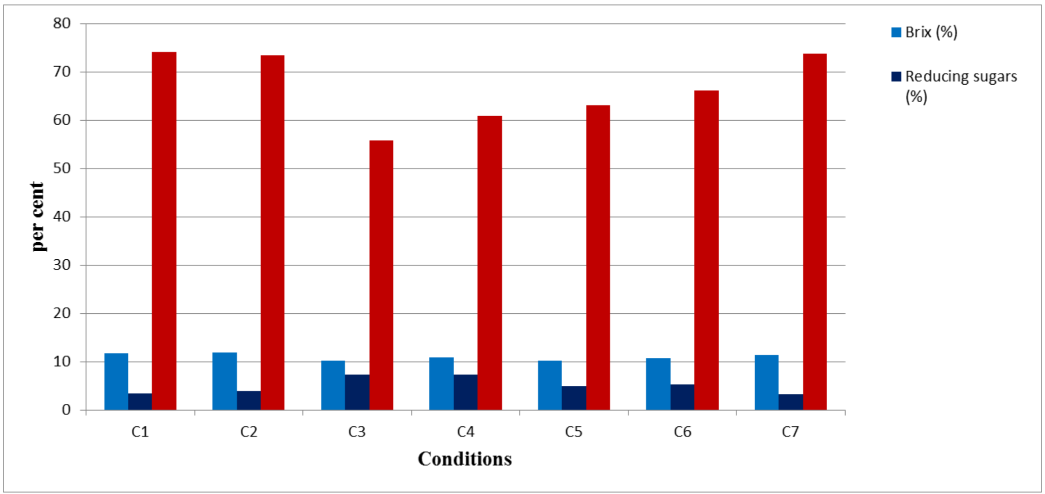

Fig. 4: Characterization of brix, reducing sugar and sucrose per cent in jaggery under adverse sugarcane production.

CONCLUSION

The sugarcane juice quality determines the jaggery quality and the important juice quality parametres include juice brix %, sucrose percent, reducing sugar and ash content in addition to moisture content of jaggery. The sugarcane production under adverse conditions like saline alkaline, shaded area and lodged conditions will deteriorate the quality of juice thereby reduce the quality of jaggery prepared from such cane. Ultimately it affects the shelf life of jaggery.

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