Evaluation of Sugarcane Genotypes for Jaggery Production in Bandarban Hill District

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ABSTRACT

Jaggery is unprocessed natural sugar produced through evaporating water from sugarcane juice in steel pans. The quality of jaggery largely depends on sugarcane varieties. Therefore, a good variety is important for quality jaggery production. For this purpose, an experiment was laid out for screening suitable genotype for the purpose of high productivity and superior quality of jaggery production in Bandarban district. Five elite genotypes, such as I 61-90, VMC 86-550, Modhumala, Ranangon and Isd 37 were selected and planted in the farmers field in Bandarban following the RCBD design during the cropping season 2015-2016. The mature cane was harvested, juice was extracted and jaggery was produced from the juice. Then, the detailed chemical and physical analyses were conducted from the produced jaggery. The highest cane (130 t ha^{-1}) and jaggery (14.44 t ha^{-1}) yield as well as jaggery recovery (11.11%) were recorded from the genotype VMC 86-550 followed by the genotypes Ranangon and Modhumala. Hard textured, good crystaline attractive brown colour jaggery was produced from the genotypes VMC 86-550, Ranangon, and Isd 37. The highest sucrose content was found in Modhumala (67.25%) followed by VMC 86-550 (59.68%). The lowest reducing sugar content (7.67%) was found in the genotype VMC 86-550 followed by Modhumala (7.69%). The genotype VMC 86-550 came out as the best one due to the highest jaggery yield (14.44 tha^{-1}), recovery (11.11%) and high sucrose level (59.68%) in jaggery. Therefore, on the basis of visual observation and chemical analysis the genotype VMC 86-550 was showed the highest yield of cane and higher recovery of jaggery.

Key words: Sugarcane genotype, yield, jaggery, recovery, quality

INTRODUCTION

Sugarcane is an important cash crop of Bangladesh. It is utilized for making sugar, jaggery (goor), juice and also consumed fresh cane for chewing purpose. Jaggery is a concentrated mass of cane juice in solid or semi solid form produced by open pan boiling method. Jaggery is a traditional sweetener of Bangladesh, it is consumed either directly by mix with other food items or used in various sweet food preparations. It has substantial nutritional and medicinal properties due to the presence of several vitamins and minerals (Singh, 1998; Singh *et al.*, 2016).

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Sugarcane occupies about 0.13 million hectares of land and annually produces nearly 5.79 million metric tons of canes with an average cane productivity 42.31 tons per hectare and average sugar recovery 6.36% (Rahman *et al.*, 2016). In Bangladesh, about 1.56 million metric tons (26.94%) of sugarcane is utilized for producing 0.10 million metric tons sugar, 3.5 million metric tons (60.44%) of the produced sugarcane is utilized for making 0.35 million metric tons jaggery and about 15% sugarcane is being used for seed, chewing and juice making purposes (Rahman *et al.*, 2016).

In general, sugarcane growers face several problems such as low extraction percentage of juice, low recovery, poor quality of jaggery. Quality jaggery comprises of high sucrose and purity with low invert sugars. It has been found that wide variation in quality of jaggery due to sugarcane varieties from which jaggery is prepared (Rakkiyappan and Janki, 1996; Singh *et al.,* 2016). Farmers always look for the sugarcane varieties having high cane yield potential with little concern about its quality components. They are very much keen to crush their cane as early as possible to vacate the cane field for sowing the next crops. Sometimes they start their crushing in early part particularly in September, October and November with mid and late maturing variety and complain regarding poor quality of jaggery. It has already been established that quality of sugarcane and juice depends on variety (Mishra, 1992). Jaggery quality depends mainly on juice and hence factors affecting the juice quality also affect the jaggery quality. Studies show that jaggery quality preferably depends on chemical composition of juice irrespective of method of boiling and clarification.

Recovery of jaggery and its quality depends on sugarcane variety, climate, physiological maturity and efficiency of crusher etc. Among the factors, variety occupies the prime place in sugar yield (Singh and Singh, 2000). Selection of sugarcane genotypes suitable for good quality jaggery production has paramount importance. The varieties suitable for jaggery making are found to be equally good for sugar production. However, a variety suitable for sugar production may not be equally suitable for jaggery making (Singh *et al.,* 1975). Chemical composition of jaggery and its quality are dependent on composition of juice from which it is made. The quality of jaggery may be influenced by climate, soil type, crop management, clarificants, stage of maturity at harvest and method of juice boiling but mainly depends upon the variety from which it is made (Kapur *et al.,*1988).

Jaggery is highly hydroscopic in nature and at high humidity period it becomes soft and sticky as a result it often liquefies completely. Some micro-organisms are responsible for fermentation which brings about various changes resulting heavy losses both in weight and quality of jaggery (Sarker *et al.,* 1985). In hill districts, there is high demand of jaggery. Farmers are cultivating chewing type of sugarcane varieties for preparation of jaggery. As a result, they are not getting satisfactory production and quality of jaggery. Therefore, suitable sugarcane genotype selection and method of high quality jaggery manufacture is very important in the cane cultivating areas. Thus, the present experiment was undertaken to find out suitable genotype for quality jaggery production in hill districts.

MATERIALS AND METHODS

The experiment was carried out in the farmer's field in Bandarban districts during the cropping season 2015-2016. Five sugarcane genotypes such as I 61-90, VMC 86-550, Modhumala, Ranangon and Isd 37 were selected for the purpose. The experiment was planted in the January, 2016. The experiment was laid out in randomized complete block design (RCBD) with three replications. Planting was done in conventional method in a plot size of 8m x 6m.

Intercultural operations including control of pests and diseases were done as and when necessary. Cane samples were collected from each plot and crushed for jaggery preparation. Data on millable cane, cane yield, jaggeery recovery, reducing sugar percentage and brix percentage were recorded. Brix was determinate by Brix hydrometric method, reducing sugar was measured by the method described by Lane and Eynon (Chen,1985). Jaggery was prepared from each genotype by simple open pan boiling method without adding any chemical clarificant. Physical and chemical properties of jaggery such as sucrose content, colour (at 0.25 N solution), pH and reducing sugars were determined from five genotypes separately followed by the method of Roy (1954). Data on sucrose, colour, moisture content of jaggery and reducing sugar percentage of jaggery from each genotype were recorded.

RESULTS AND DISCUSSION

Jaggery yield and recovery in relation to yield attributes of cane

Results of the experiment showed that there were significant differences among the tested genotypes (Table 1) in yield and their contributing parameters of cane and jaggery. The highest number of millable cane ($92.85x10^3ha^{-1}$) was found in VMC 86-550 and the lowest in Modhumala ($50.43x10^3ha^{-1}$).The highest single stalk weight was obtained in Modhumala (2.37kg) followed by Ranangon (1.94 kg) and VMC 86-550 (1.40kg). The highest cane (130 t ha^{-1}) and jaggery (14.44 t ha^{-1}) yield was found in the genotype VMC 86-550 followed by the genotypes Ranangon and Modhumala. It was observed that the highest cane and jaggery yield of VMC 86-550 was contributed by its higher number of millable cane and higher juice extraction percentage. Jaggery recovery of different genotypes ranged from 9.04-11.11% was observed. The highest recovery was found in VMC 86-550 (11.11%) followed by Isd 37 (10.40%), Modhumala (9.45%) and Ranangon (9.40%); the lowest was 9.04% in I 61-90.

Physical properties of jaggery

The genotypes VMC 86-550, Ranangon, and Isd 37 showed hard texture and good crystaline nature with attractive brown colour of jaggery. Only Modhumala produced good crystaline golden coloured jaggery. The genotype I 61-90 produced gummy textured non-crystraline golden coloured jaggery. Singh *et al.* (2018) reported that the jaggery may be categorized in different grades depending on its colour from light golden, golden, dark golden, light brown to brown; however according to Indian standard light golden colour can be combined as a special grade.

Table 1. Yield attributes of cane and jaggery produced from sugarcane genotypes at farmer's field at Bandarban, 2015-16

Genotypes	Number of millable cane ($x10^3 ha^{-1}$)	Single cane weight (kg)	Cane yield (tha^{-1})	Juice extraction (%)	Recovery of jaggery (%)	Jaggery yield (tha^{-1})
I 61-90	70.83 b	1.33 b	95 c	55.63 bc	9.04 b	8.58 b
VMC 86-550	92.85 a	1.40 b	130 a	65.67 a	11.11 a	14.44 a
Modhumala	50.43 d	2.37 a	120 b	58.86 b	9.45 b	11.34 ab
Rananggon	65.98 c	1.94 a	128 ab	59.04 b	9.4 b	12.03 ab
Isd 37	69.4 b	1.34 b	93 c	49.46 c	10.14 ab	9.43 b
LSD (0.05)	1.80	11.73	3.58	4.81	6.89	17.37

Table 2. Physical properties of jaggery produced at Bandarban

Genotypes	Texture	Crystaline nature	Colour in solid state
I 61-90	Soft	Non crystal	Golden
VMC 86-550	Hard	Good	Brown
Modhumala	Hard	Good	Golden
Rananggon	Hard	Good	Brown
Isd 37	Hard	Good	Brown

Chemical properties of jaggery

Significant differences were observed among the genotypes in brix percentage. The highest brix percentage (21.50%) was recorded in VMC 86-550 and the lowest was in I 61-90 (15.00%). Sucrose is the major sweetening agent; there were significant differences among the genotypes in sucrose content. The highest sucrose content was found in Modhumala (67.25%) followed by VMC 86-550 (59.68%) and Isd 37 (55.65%). The lowest sucrose content was observed in I 61-90 (44.43%). Reducing sugar content is an important quality parameter of jaggery because higher concentration of reducing sugars softens the prepared jaggery due to its hygroscopic nature. There were significant differences for reducing sugars among five genotypes (Table 3). The lowest reducing sugar content (7.67%) was found in the genotype VMC 86-550 followed by Modhumala (7.69%). High reducing sugar (11.95%) was observed in the genotype I 61-90 which indicated poor quality jaggery. These explanations are in

agreement with the results reported by Hussain *et al*. (2007). Quality of jaggery is directly related with its pH, low pH indicates high acidity which deteriorates jaggery quality. The lowest pH (5.32) was observed in the genotype Modhumala followed by the genotypes Isd 37, Rananggon and I 61-90. Higher pH (5.75) which indicates the lowest acidity was observed in the genotype VMC 86-550. Comparing five genotypes, pH of the Jaggery produced from the genotype VMC 86-550 was equivalent to neutral which was suitable for consumption and long period storage. These results are in agreement with Patil *et al*. (1994) who reported variable acidity in eleven sugarcane varieties before and after storage. The higher moisture contents in jaggery deteriorate its quality by darkening colour and encouraging microbial growth. There were significant differences for moisture contents in jaggery among the genotypes. The highest moisture (9.98%) was shown by jaggery from the genotype I 61-90 while the lowest moisture (5.26%) was exhibited by jaggery of the genotype Modhumala. These observations are in line with Hussain *et al*. (2007) who reported a variable tendency of moisture absorption and contents among different sugarcane varieties.

Table 3. Chemical properties of Jaggery produced at Bandarban

Genotypes	Brix (%)	Sucrose (%)	Reducing Sugar (%)	pH	Moisture (%)
I 61-90	15.00 c	44.43 e	11.95 a	5.60	9.98 a
VMC 86-550	21.50 a	59.68 b	7.67 b	5.75	7.67 b
Modhumala	18.00 b	67.25 a	7.69 b	5.32	5.26 c
Rananggon	18.00 b	48.74 d	10.43 b	5.60	8.50 ab
Isd 37	17.00 bc	55.65 c	10.71 b	5.50	8.15 ab
CV (%)	6.54	2.03	12.69	10.89	12.03

The results revealed that the genotype VMC 86-550 came out as the best one on account of showing the highest jaggery yield (14.44 t ha^{-1}), recovery (11.11%) and high sucrose level (59.68%) of prepared jaggery. On the basis of visual observation and chemical analysis the genotype VMC 86-550 was rated excellent in quality for jaggery making in the cane cultivating areas of Bandarban hill districts.

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