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RESEARCH NOTE

Performance Study of Indigenously Made Sugarcane Crushers

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Abstract

In the present study, four types of sugarcane crushers commonly used in Karnataka in jaggery making industries were evaluated. They were Power driven 3-Roller traditional type, heavy duty type and gear box type crushers used in jaggery industries for crushing sugarcane and 2-Roller power driven sugarcane crusher used by venders for extraction of juice for local consumption. Six varieties of high yielding sugarcane cultivars namely viz., CO419, CO62175, CO7804, B37172, CO8371 and CO86032 which are commonly grown in Karnataka, were selected for crushing operation. The parameters studied include quantity of juice extracted and weight of bagasse obtained in each system of crushing and the varieties of cane crushed. It was observed that as the number of crushing cylinders increased, crushing of cane would be more effective leading to increase in per cent age of juice extraction with reduction in bagasse weight.

Keywords: Crushers, cultivars, crushing efficiency, purity of juice

Sugarcane is an important commercial crop of India producing over 300MT of sugarcane to feed over 450 sugar producing industries. In Karnataka on an average 50 per cent of the sugarcane produced is crushed in sugar industries adopting modern crushers, 40 per cent of the sugarcane produced is used in jaggery industries with traditional 3-roller sugarcane crushers manufactured locally and the rest 10 per cent of the sugarcane produced is used for seed purpose and extraction of juice for local consumption using 2-roller hand / power driven portable crushers (Baboo and Solomon, 2000). As per the estimate, up to 79 per cent of the juice is extracted from the sugarcane using modern screw press type crushers in the sugar industries. On the other hand, on an average 50 to 55 per cent of juice is extracted from the sugarcane using traditional 3-rollers crushers in the jaggery industries. The remaining portion of the juice extraction is the bagasse that burnt as fuel (Baboo and Solomon, 2000). Thus, there is a large possibility of improving the juice extraction up to 80 per cent by adopting crushers having more than 3-rollers/ cylinders. According to Singh (2004), horizontal type of rollers have bet er crushing efficiency and juice extraction than the vertical type of rollers. Hence, there is a need to incorporate certain modifications in the traditional crushers used in jaggery industries to improve the cane crushing and juice extraction

efficiency. Keeping these observations in view and the importance of extracting maximum juice from sugarcane and to make jaggery industry economically viable, the present study was undertaken with the detailed information on the design of the existing sugarcane crushers used in jaggery industries, their merits and demerits information on their working performance was collected by visiting the jaggery industries. It can be achieved after comparing the performance of the presently used crushers with the available varieties of sugarcane. The results obtained are discussed in this paper.

Materials and Methods

Power driven 3-Roller traditional type (Figure 1), heavy duty type (Figure 2) and gear box type crushers (Figure 3) used in jaggery making industries for crushing sugarcane and 2-Roller power driven sugarcane crusher (Figure 4) used by venders for extraction of juice for local consumption were selected and evaluated for their performance. The performance evaluation study was conducted under the actual field conditions during sugarcane crushing season in Mandya District of Karnataka.

Six varieties of high yielding sugarcane cultivars namely CO419, CO62175, CO7804, B37172, CO8371 and CO86032, commonly cultivated in Karnataka were selected for crushing operation. The parameters studied included quantity of juice extracted and weight of bagasse obtained in each system of crushing and the varieties crushed were recorded. In addition, juice quality of each variety of cultivars namely, total soluble solids °Brix, Sucrose content, Reducing sugars and Purity per cent were analyzed statistically using Reliability Random Diagram method (RBD). The analysis of juice was done under laboratory conditions at Agricultural College, V.C. Farm. Mandya, the following Standard procedures (A.O.A.C., 1980) and methods for conducting the study.

Quantity of juice extracted

The juice extracted in each sugarcane crusher was filtered through a fine cloth to remove the suspended impurities such as fine particles of bagasse, trash etc. and used for analysis.

Weight of bagasse

The bagasse that came out after crushing was weighed. The juice left over in the bagasse was estimated by drying a known quantity of bagasse in an oven at 80 °C for 30 hours (AOAC, 1980).

Analysis of Juice: The quality of the juice extracted from varieties of cane crushed and the type of crushers used for extracting juice was analysed. The juice extracted from six varieties of cane using four different type of crushers was analyzed for °Brix content, sucrose, reducing sugars and purity.

Brix

The composite sample of filtered juice was filled in a cylinder into which Brix hydrometer was suspended and its reading was recorded along with temperature of juice and corrected TSS was computed (Anon, 1986). The experiment was repeated thrice and the average reading was computed.

Reducing sugars

The reducing sugars (%) was estimated by titrating the sugarcane juice clarified with lead acetate with 10 ml of Fehlings (A+B) solution according to Lane and Eynon's Volumetric method (A.O.A.C., 1980). The calculations were made as given below:

$$\text{Reducing sugars percent} = \frac{(0.05 \times \text{Volume of juice})}{(\text{T.V. x Wt. of juice})} \times 100$$

where T.V. is the Titre value

Sucrose content (%)

One hundred ml of filtered juice was transferred to 250 ml conical flask to which one gram of basic lead acetate was added. Stirred well and allowed to stand for about an hour until clear supernatant was obtained. The supernatant was filtered through Whatman No. 40 filter paper and clarified juice was filled into succhroliser tube and pol reading was recorded. The corrected pol reading were obtained

Fig. 1: Power Driven 3-Roller Traditional Sugarcane Crusher

Fig. 2: Heavy Duty 3-Roller Sugarcane Crusher

Fig. 3: Gear Box 3-Roller Sugarcane Crusher

Fig. 4: 2-Roller Power Driven Sugarcane Crusher

by comparing the pol reading measured with the corresponding corrected Brix by reading referring to Schmitz table (Anon, 1986).

Purity percent (%)

The purity of sugar cane process stream products (e.g., cane juice, molasses, raw sugar etc.) is a measure of product quality and was determined by calculating the ratio of %Sucrose and %Total soluble Solids as a percentage which were measured by double polarisation and dry substance measurements, respectively.

The ratio of sucrose per cent to the corrected Brix was expressed as purity of the juice, which indicate the proportion of sucrose in the total soluble solids present in juice (Anon, 1986). The experiment was repeated thrice and average reading was computed, as given below:

$$\text{Purity percent} = \frac{\text{Sucrose percent}}{\text{Corrected Brix}} \times 100$$

Statistical analysis

The data were analyzed by ANOVA and SEM and critical differences (CD) have been presented.

Results and Discussion

Amount of juice extracted

The quantity of juice extracted (g/kg) from each system of crushing and variety of sugarcane crushed is recorded and presented in Table 1. It is observed that the amount of juice extracted vary from cultivar to cultivar in each system of crushing. This may be due to the characteristics of cultivars and the method of juice extraction. From the data, it could also be observed that the power driven 3-roller gear box type sugarcane crusher proved bet er in extracting juice from the varieties of sugarcane crushed (547 to 588 g/kg of cane crushed), followed by 3-roller traditional type sugarcane crusher (477 to 515 g/kg) and 3-roller heavy duty type sugarcane crusher (444 to 525 g/kg) used in jaggery industries. The

Table 1: Amount of Juice Extracted (g/kg of cane crushed)

	Sugarcane Varieties						
Type of crushers	**CO419**	**CO62175**	**CO7804**	**B37172**	**CO8371**	**CO86032**	**Mean**
Two roller power operated sugarcane crusher	452	412	442	458	435	460	443
Three roller power operated traditional sugarcane crusher	477	508	505	480	512	515	499
Three roller power operated heavy duty sugarcane crusher	522	444	480	478	502	525	491
Three roller power operated gear box type sugarcane crusher	547	583	578	568	570	588	**572**

SEM = 31.79, CD @5%=77.33, Significant

Table 2: Weight of Bagasse (g/kg of cane crushed)

	Sugarcane Varieties						
Type of crushers	**CO419**	**CO62175**	**CO7804**	**B37172**	**CO8371**	**CO86032**	**MEAN**
Two roller power operated sugarcane crusher	574	629	584	565	564	560	579
Three roller power operated traditional sugarcane crusher	504	428	432	502	424	420	451
Three roller power operated heavy duty sugarcane crusher	387	489	470	474	392	385	432
Three roller power operated gear box type sugarcane crusher	453	424	426	415	412	402	**422**

SEM= 51.59, CD @ 5% = 125.47, Significant

juice extracted by power driven 2-roller sugarcane crusher used by venders is comparatively less than that of 3-roller power driven crushers. The variation in juice extracted from the systems of crushing could be due to variation in their design parameters such as clearance between the rollers, serrations made on the periphery of the roller, speed of roller and quantity of cane fed per unit time. The data recorded matche with that of Singh (2004).

Weight of bagasse (g/kg)

The weight of bagasse available af er extraction of juice vary from variety to variety of cane crushed depending upon the fiber content in the cane and the per cent of juice extracted. It is evident from the data presented in Table 2 that the weight of bagasse recorded af er extracting juice using 3 roller gear box type sugarcane crusher was comparatively less (402 to 453g/kg of cane crushed) followed by cane crushed using 3 roller traditional sugarcane crusher (420 to 504 g/kg), 3 roller heavy duty sugarcane crusher (385 to 470 g/kg), and 2 roller sugarcane crusher (560 to 629g/kg).

It could also be seen from the Table 1 that the per cent of juice extracted using 3 roller gear box type sugarcane crusher was higher (547 to 588 g/kg of cane crushed), hence recorded less weight of bagasse available af er juice extraction as compared to other methods of cane crushing where the extraction of juice was less leading to higher weight of bagasse due to presence of juice in the bagasse. These findings hold good with the findings of Hunsugi (2001).

The data recorded on juice analysis are presented in Tables 3, 4, 5 and 6 respectively which showed variations in these varieties for total solids, sucrose, reducing sugars and purity. The per cent of Brix

Table 3: Percentage of Brix Content of the juice

	Sugarcane Varieties						
Type of crushers	**CO419**	**CO62175**	**CO7804**	**B37172**	**CO8371**	**CO86032**	**Mean**
Two roller power operated sugarcane crusher	20.00	19.80	19.70	20.00	21.00	19.90	20.06
Three roller power operated traditional sugarcane crusher	18.80	21.00	20.00	20.00	20.05	20.00	19.97
Three roller power operated heavy duty sugarcane crusher	19.10	19.50	19.00	19.80	19.30	20.00	19.45
Three roller power operated gear box type sugarcane crusher	20.05	19.50	19.00	21.00	21.00	20.80	**20.22**

Sem= 0.87, CD@5% = 2.12, Significant

Table 4: Sucrose Percent of the Juice

	Sugarcane Varieties						
Type of crushers	**CO419**	**CO62175**	**CO7804**	**B37172**	**CO8371**	**CO86032**	**Mean**
Two roller power operated sugarcane crusher	20.00	19.70	19.50	19.80	20.90	19.80	20.22
Three roller power operated traditional sugarcane crusher	18.70	21.00	19.70	19.99	20.10	20.00	21.18
Three roller power operated heavy duty sugarcane crusher	19.10	19.40	19.00	19.75	19.40	20.00	21.39
Three roller power operated gear box type sugarcane crusher	20.00	19.30	18.95	20.80	20.80	20.70	**22.60**

SEM= 0.66, CD@5%=1.60, Significant

Table 5: Reducing Sugars (%) of the juice

Type of crushers	Sugarcane Varieties						
	CO419	CO62175	CO7804	B37172	CO8371	CO86032	Mean
Two roller power operated sugarcane crusher	7.59	7.19	7.10	7.69	7.79	7.00	7.39
Three roller power operated traditional sugarcane crusher	6.92	7.66	7.42	7.50	7.10	7.75	7.39
Three roller power operated heavy duty sugarcane crusher	8.98	7.59	6.48	6.36	5.84	8.24	7.24
Three roller power operated gear box type sugarcane crusher	7.48	7.47	7.46	7.50	7.78	7.53	**7.53**

SEM= 1.09, CD@5%=2.66, Significant

Table 6: Purity (%) of the juice

Type of crushers	Sugarcane Varieties						
	CO419	CO62175	CO7804	B37172	CO8371	CO86032	Mean
Two roller power operated sugarcane crusher	98.00	97.90	98.10	98.5	99.00	98.00	98.25
Three roller power operated traditional sugarcane crusher	98.00	99.00	98.00	98.20	98.50	99.50	98.53
Three roller power operated heavy duty sugarcane crusher	98.5	99.00	98.50	99.00	98.50	99.50	98.83
Three roller power operated gear box type sugarcane crusher	99.80	100.00	99.90	99.70	99.60	100.00	99.83

SEM= 0.94, CD@5.5%=2.28, Significant

content (Gupta, 1981), sucrose (Gravios *et al*., 1991), reducing sugars (Srivastava *et al.,* 2002) and purity (Rekhi and Gil 1987) available in the juice vary from variety to variety of cane. This may be due to the specific characteristic of each cultivars. However, it could be seen that the type of crushers used for extracting juice played no role as far as the Brix content, sucrose content and reducing sugars in the juice are concerned. However, there was also a lit le variation in the purity per cent of juice extracted from different types of crushers used. This variation may be due to the contamination juice with lubricants and the hygienic conductions maintained around the crushers during crushing operations. Among the crushers used, the purity of juice extracted using 3 roller gear box type sugarcane crusher was found bet er than the juice extracted from the crushers under study. Essentially purity describes how much pure sucrose is present in a sugarcane juice sample.

Conclusion

It could be concluded from the study that the number of rollers increases the amount of juice extracted (gm/kg) and Bagasse weight (gm/kg). Brix content (%) sucrose content (%), reducing sugars and purity per cent but were not affected by the number of rollers present in the crusher. Similarly, there is not much variation in the values of varieties of sugarcanes used for the study. Method of crushing and type of crushers used is important to maintain the hygiene conditions and to obtain the purity of juice.

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