



## Studies on the preparation of liquid jaggery from sugarcane (*Sacharum officinarum* L.) juice

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### Abstract

Sugarcane (*Sacharum officinarum*. L) is one of the important cash crops which are available in plenty during the season. It is a good source of sugar, minerals and polyphenols. So, the production of liquid jaggery from the sugarcane juice is most viable processing method in the rural cottage industry to exploit these characters. Sugarcane juice was extracted and 2000 ppm potassium metabisulphite was added and clarified by muslin cloth, centrifugation and membrane filtration/micro filtration. The clarified sugarcane juice was further concentrated up to 65 °B in an open pan evaporator and the product obtained in the form of liquid jaggery was filled in a transparent glass bottle and. Among the clarification process, the liquid jaggery obtained through the micro filtered clarified juice was found to be superior and it contains highest amount of magnesium (15.77±0.03 mg/100g) and iron (10.95±0.05 mg/100g) than other clarification methods.

**Keywords:** liquid jaggery; centrifugation; microfiltration

### Introduction

Jaggery is a natural product obtained from the concentrated juice of sugarcane [16], sugar beet [9], coconut palm [8] date palm and palmyra [12, 7]. Jaggery is also known as Gur in India [14], Desi in Pakistan, Hakaru in Sri Lanka, Htanyet in Myanmar and jaggery in African countries [13] and Rapadura in Brazil, Panela in Central American countries and Mexico. In India, jaggery, brown sugar and khandsari are popular products among the rural masses as a traditional sweetener. The jaggery is rich in sugar, minerals and molasses. It is available in the market mainly in three different forms viz., solid jaggery, granular jaggery and liquid jaggery [13].

The sugar syrup obtained from a clarified and concentrated sugarcane, date palm, palmyra and sugarbeet juice of having TSS 60-65°B is called as liquid jaggery. The liquid jaggery is consumed in the various parts of Bihar, Jharkhand, Odisha, West Bengal and Maharashtra [14], and has been gaining commercial importance. Liquid jaggery is used to prepare the soft drinks [13] and traditional snack foods. It is also used in the formulation and preparation of herbal elixir [17]. Jaggery is a natural functional food which is rich in polyphenols, vitamin C, carotene and other bioactive compounds that has antioxidant and cryoprotective activities [19]. Iron present in the liquid jaggery helps to prevent the anemia in women and children. *In vivo* studies showed that jaggery supplement reduced the toxicity of arsenic [18] and serve as alternative medicine in the treatment of hepatic and renal toxicity [10].

Jaggery manufacturing is typically agro-based small scale industry owned and managed by farmers. Nearly, 25-30 % of sugarcane produced in the country is utilized for production of jaggery and khandsari [16] and provides employments to about 2.5 million people [17].

Traditionally, liquid jaggery is produced by evaporating

sugarcane juice in a large open atmospheric pan and bagasse is used as fuel biomass on the clay stove [15] to heat the sugarcane juice until it becomes concentrated. The herbal clarifying agent such as deola (*Hibiscus ficulneus*), kateshevari, chikani and mucilage's of lady's finger [3] is used during the boiling of concentrated sugarcane juice. Chemical clarificants like lime (Calcium hydroxide), hydros superphosphate, phosphoric acid, chemiflocks and alum are also used, and among them lime is widely used clarificants. The final products quality of liquid jaggery is judged by the producer based on its intensity of brown colour, thickness and viscous liquid during the concentration of sugarcane juice. The quality of liquid jaggery depends on variety of sugarcane grown, method of clarification, processing temperature and time, packaging method and storage condition [5].

The review of the literature showed that the information on production of liquid jaggery through different clarification method of sugarcane juice is scarce, whereas the demand of liquid jaggery has shown increased for its various applications in food preparations and its nutritional properties. There is great potential for large scale production of quality liquid jaggery in a hygienic way. In view of above constraints for preparation of liquid jaggery the investigation on "studies on preparation of liquid jaggery from sugarcane (*Sacharum officinarum* L.) juice" was taken to enrich the existing knowledge.

### Material and Method

#### Raw Materials

To evaluate the juice yield and other physicochemical parameters in the laboratory, the sugarcane juice was procured from the local vendor near the CFTRI, campus, Mysore. The local vendor extracted the juice by using horizontal screw press

fitted with two rollers. For further experiment, matured sugarcane stalks of a local variety having long internodes of uniform length, healthy and free from disease and pest attack were procured from the local market of Mysore. All the sugarcane stalks were cut into two pieces and washed manually by spraying water, using a scrubber to remove muds and dust particles. The sugarcane juice was extracted at CFTRI, pilot plant by using a horizontal screw press extractor fitted with six rollers. The extracted juice was preserved with 2000 ppm of potassium metabisulphite.

### Clarification

The sugarcane juice was clarified by three different treatments. The control sample (T0) without treatment, extracted 10 liters of sugarcane juice was kept without straining, for preparation of liquid jaggery. In the first treatment (T1), after crushing the sugarcane, juice was strained through a muslin cloth to remove bagasse, mud, sand, debris and other impurities from the juice. The second treatment (T2) was done by adding 8 ml lime solution in 10 liters of juice at the time of boiling, which enhanced the scum formation and facilitated the clarification process [13]. The third treatment (T3), includes the centrifugation of sugarcane juice [6], which was done at 4000 RPM for 10 minutes and suspended debris were removed and 10 liters of clarified juice was obtained. The fourth treatment (T4) was performed with the help of microfiltration [1, 2] where the sugarcane juice was clarified. The microfiltration unit consist of multi-channel ceramic membrane having 0.2  $\mu$  pore size and 0.3 m<sup>2</sup> membrane area was used for the experiments. The experiment was performed at temperature 25° C, at a constant trans-membrane pressure (TMP) of 2 bars. A total of 17 kg of permeate (filtrate) was collected in one hour, which is equivalent to permeate flux of 57kg/h/m<sup>2</sup>.

### Concentration, packaging and storage

The clarified juice was concentrated in an open pan evaporator at a temperature 110 °C and ambient pressure. The sample was checked at different stages of evaporation and analyzed for TSS to judge the end point of liquid jaggery. Hot thick syrup of TSS 65 °B, which is called as liquid jaggery was filled into pre-sterilized glass bottle of 200 ml capacity followed by crown corking. The filled glass bottles were pasteurized in hot water 85 °C for 15 minutes followed by air cooling. The prepared liquid jaggery was stored in the refrigerated condition for physicochemical analysis.

### Physicochemical analysis of the samples

Viscosity of the sugarcane juice and liquid jaggery was measured in millipascal-second (m-Pa.s)/centipoise (cp) by using Brookfield Synchro-Lectric Viscometer. PH was determined by using a digital pH meter (Control Dynamics Company, Bangalore, India) at room temperature. The percentage of total soluble solids (w/w) of the sugarcane juice and liquid jaggery was determined with the help of a hand refractometer (RX-5000, ATAGO Co. Ltd., Japan). Total titrable acidity was determined by titrating a known weight of juice with 0.1N NaOH solution using phenolphthalein as an indicator. The results were expressed as percent anhydrous citric acid (w/w) [11]. The moisture content of the liquid

jaggery was estimated by oven-drying method as per the procedure given by Ranganna [11]. Total ash was estimated by incineration and drying in a muffle furnace at 550-600°C as per the procedure given by Ranganna [11]. Mineral constituents (Ca, Mg, and Fe) were determined using an atomic absorption spectrophotometer. Total sugar and reducing sugars are measured by using Lane and Eynon Method [11].

## Results and Discussion

### Juice yield and physicochemical properties of sugarcane

The sugarcane juice yield of local vendor and CFTRI-pilot were determined by weighing the sugarcane stalk weight and obtained juice (w/w) in percentage. The local vendor was extracted the sugarcane juice through the horizontal screw press which has two-roller cane crusher; whereas the juice extractor used in the CFTRI-pilot plant was horizontal screw press which contains six-roller cane crusher. The sugarcane juice purchased from local vendor and juice extracted in the pilot plant at CFTRI, Mysore were analyzed for their physicochemical properties and given in table 1. Juice yield was obtained 53.28±0.03% in case of local vendor; whereas the juice yield was 56.24±0.04 % in case of CFTRI, pilot plant. The above finding indicates that the sugarcane juice yield was higher in case of horizontal screw press juice extractor containing six-roller. The total soluble solid of the sugarcane juice was 17.50±0.10° Brix in case of local vendor where as in case of CFTRI-pilot plant the TSS of sugarcane juice was 18.50±0.10° Brix. The moisture content of sugarcane juice obtained from local vendor and CFTRI pilot was found to be 81.90±0.05% and 80.00±2.00 respectively. The total sugar was 18.10±0.03% found in local vendor; whereas 19.11±0.02 % was found in CFTRI-pilot plant. pH (5.15±0.03) and viscosity (3.82±0.02) was slightly higher in the juice obtained from CFTRI. The differences in these parameters are due to utilization of top portion of the cane by local vendor during the extraction of juice. Besides these parameters, juice obtained from the local vendor was not hygienic although the physicochemical property was more or less similar and agreed with the finding of Chauhan *et al.* [2].

**Table 1:** Physicochemical properties\* of Sugarcane juice from local vendor and CFTRI Pilot Plant

Parameters	Local Vendor	CFTRI Pilot Plant
Juice yield	53.28 ± 0.03	56.24 ± 0.04
Viscosity (m Pa.S)	3.68 ± 0.05	3.82 ± 0.02
Moisture (%)	81.90 ± 0.05	80.00 ± 2.00
Ash (%)	15.43 ± 0.03	13.30 ± 0.05
TSS (°B)	17.50 ± 0.10	18.50 ± 0.10
Total Sugar (%)	18.10 ± 0.03	19.11 ± 0.02
Reducing sugar (%)	0.48 ± 0.03	0.33 ± 0.03
pH	5.15 ± 0.03	5.25 ± 0.05
Acidity	0.24 ± 0.04	0.30 ± 0.01

\*Values are mean ± standard deviation (n=3); Local vendor and CFTRI-Pilot plant, Mysore.

### Physicochemical properties of liquid jaggery

The liquid jaggery were prepared by five different treatments Viz., T0= Control, T1= Juice clarified through muslin cloth, T2= Juice clarified by using sodium hydroxide (NaOH), T3= Juice clarified through centrifuge, T4= Juice clarified through

membrane filtration. The sample were collected at 65°Brix and analyzed for their important constituents. The obtained results are presented in table 2. The moisture percentage varies from 26.13±0.06% to 28.93±0.01%. Highest moisture percentage was found in liquid jaggery prepared by juice clarified through membrane filtration whereas lowest moisture content was found in liquid jaggery obtained through lime treated juice. The total ash percentage was found to varies from 3.50±0.02 to 4.99±0.01, in the liquid jaggery. The mineral content like calcium is highest (6.06 ±0.02 mg/100g) in liquid jaggery treated with lime, higher amount of magnesium (15.77±0.03

mg/100g) and iron (10.95±0.05 mg/100g) was also found in liquid jaggery prepared by using membrane filtration and Nath *et al.* also reported that liquid jaggery has more or less similar amount of iron content [8]. The highest reducing sugar (16.52±0.02%) and total sugar (61.20±0.10%) was found in liquid jaggery obtained through membrane filtration. pH of liquid jaggery prepared by lime treatment was highest 6.76±0.02, which is expected whereas the lowest pH was found in liquid jaggery obtained from juice clarified through the muslin cloth.

**Table 2:** Physicochemical characteristics\* of liquid jaggery prepared by different treatment.

Parameters	T0	T1	T2	T3	T4
Moisture (%)	28.64 ± 0.04	28.85 ± 0.01	26.11 ± 0.06	26.12 ± 0.03	28.93 ± 0.01
Total ash	3.96 ± 0.02	4.85 ± 0.05	3.50 ± 0.02	4.99 ± 0.01	3.90 ± 0.01
Calcium	5.40 ± 0.02	5.12 ± 0.02	6.06 ± 0.02	5.00 ± 0.02	5.27 ± 0.03
Magnesium	14.03 ± 0.07	14.45 ± 0.05	14.74 ± 0.02	14.47 ± 0.01	15.77 ± 0.03
Iron	10.87 ± 0.02	10.54 ± 0.01	10.76 ± 0.02	10.48 ± 0.02	10.95 ± 0.05
Reducing Sugar (%)	14.77 ± 0.03	15.75 ± 0.05	16.08 ± 0.02	16.52 ± 0.02	15.77 ± 0.03
Total sugar	59.13 ± 0.06	60.20 ± 0.10	60.92 ± 0.02	61.20 ± 0.10	57.93 ± 0.02
pH	5.23 ± 0.01	5.21 ± 0.01	6.76 ± 0.02	5.32 ± 0.02	5.26 ± 0.02

\*Values are mean ± standard deviation (n= 3); T0= Control, T1= Juice clarified through muslin cloth, T2= Juice clarified by using sodium hydroxide (NaOH), T3= Juice clarified through centrifuge, T4= Juice clarified through membrane filtration.



**Fig 1:** Photograph of liquid jaggery packed in glass bottle prepared by different treatments; T0= Control, T1= Juice clarified through muslin cloth, T2= Juice clarified by sodium hydroxide (NaOH), T3= Juice clarified by centrifuge, T4= Juice clarified by membrane filtration

## Conclusion

Jaggery is an important natural sweetener which is manufactured from sugarcane juice, and used in the preparation of herbal medicine and beverages. The liquid jaggery prepared through membrane filtration demonstrated superior quality of the product. Therefore, production of liquid jaggery on commercial level could be employed through microfiltered sugarcane juice to get the quality liquid jaggery.

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