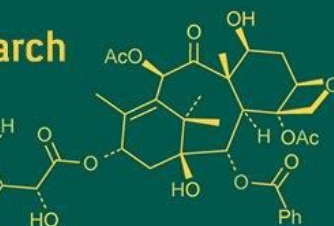
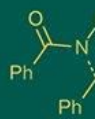
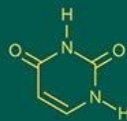
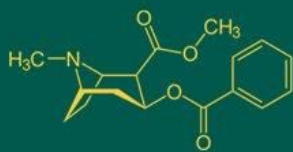


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Development and quality evaluation of liquid jaggery prepared from sugarcane varieties Co 86032, MS 10001 and MS 8005 using okra mucilage as a natural clarificant

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Abstract

The present study emphasized on preparation of liquid jaggery samples from Co 86032, MS 10001 and MS 8005 by using 2.5 percent okra mucilage as clarificant. Liquid jaggery samples were prepared from juice extracted from sugarcane variety Co 86032 (LV₁), MS 10001 (LV₂) and MS 8005 (LV₃). Sample LV₁ was found highest in yield (20.50 percent), viscosity (807.33 Cp), specific gravity (1.95) and density (1.34 gm/cm³). Sample LV₃ had highest pH (5.93) and reducing sugar (17.32 percent) while lowest titrable acidity (0.281). Among prepared samples, LV₁ was found highest in TSS (68.31° Bx) and nonreducing sugar content (51.83 percent). Results of proximate composition of samples showed that values of carbohydrate and ash content was highest in case of sample LV₁ (61.42 percent and 3.55 percent). All samples were evaluated for mineral content. Among all samples LV₁ was high in calcium (66.75 mg per 100 gm), phosphorous (40.93 mg per 100 gm), iron (11.02 mg per 100 gm), zinc (0.35 mg per 100 gm), manganese (0.27 mg per 100 gm) and copper (0.16 mg per 100 gm).

Keywords: Development, quality evaluation, liquid jaggery, proximate analysis, minerals

Introduction

Sugarcane (*Sacharum officinarum* L.) is one of the important cash crop which is 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 (Manzar H. and Singh N., 2018) [8].

The regular and high consumption of white sugar results in many health-related problems including dental, stomach problems, diabetes, obesity, etc. However, jaggery is rich in minerals, antioxidants, vitamins and protein. Still, the wider societal acceptance and consumption of jaggery products are limited because of poor hygiene in manufacturing, the use of excessive chemicals to get attractive colors and poor shelf life of the produce (Rao G. and Singh P., 2022) [5].

Liquid jaggery is alternative source to honey. It is an intermediate product collected during jaggery manufacturing at striking temperature in the range from 105°C to 108°C or generally it depends upon the varieties of sugarcane used (Patil S. and Anekar S., 2014) [10].

Liquid jaggery is used to prepare the soft drinks, traditional snack foods and herbal medicinal solution. Jaggery is a natural functional food which is rich in polyphenols, vitamin C, carotene and other bioactive compounds that has antioxidant and cryoprotective activities. 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 and serve as alternative medicine in the treatment of hepatic and renal toxicity (Raghuvanshi S. and Shukla S., 2014) [2].

Magnesium in jaggery strengthens human nervous system, helps to relax body muscles, gives relief from fatigue and takes care of blood vessels. It also acts as an antioxidant along with selenium. Jaggery contains potassium and low amount of sodium which helps to maintain the acid balance in the body cells and controls body blood pressure. Jaggery is called as rich source of iron which helps to prevent anemia. Because of its anti-allergic properties it helps to relief tension and takes care of asthma (Kumar D. *et al.*, 2013; Singh J. *et al.*, 2011) [6, 17]

Materials and Methods

Sugarcane: Sugarcane of different varieties namely Co 86032, MS 8005 and MS 10001 was procured from Regional Sugarcane Research Center, Vasmat, Dist. Hingoli.

Chemicals: Chemicals required for present investigation were obtained from Department of Food Chemistry and Nutrition and Department of Food Microbiology and Safety, College of Food Technology, VNMKV, Parbhani.

Extraction of sugarcane juice

Extraction of sugarcane juice was carried out by using electric power operated horizontal screw two roller cane crusher (Said P. and Pradhan R., 2013) [16].

Preparation of okra mucilage

Okra mucilage was prepared by procedure of Chavan J. *et al.*, (2007) [2]. Fresh green mature lady fingers stalks were cut into 1-1.5 cm pieces, macerated with water (1:10 w/v) in a mortar and pestle, allow to stand for 6 hr at ambient conditions followed by centrifugation at 8000 rpm for 20 min. Mucilage in supernatant was flocculated by ethanol (50:50 v/v), manually separated and washed with acetone to remove green pigments thus white mucilage was obtained.

Preparation of Liquid Jaggery

Liquid jaggery was prepared according to the procedure given by Chikkappaiah L. *et al.*, (2017) [3]

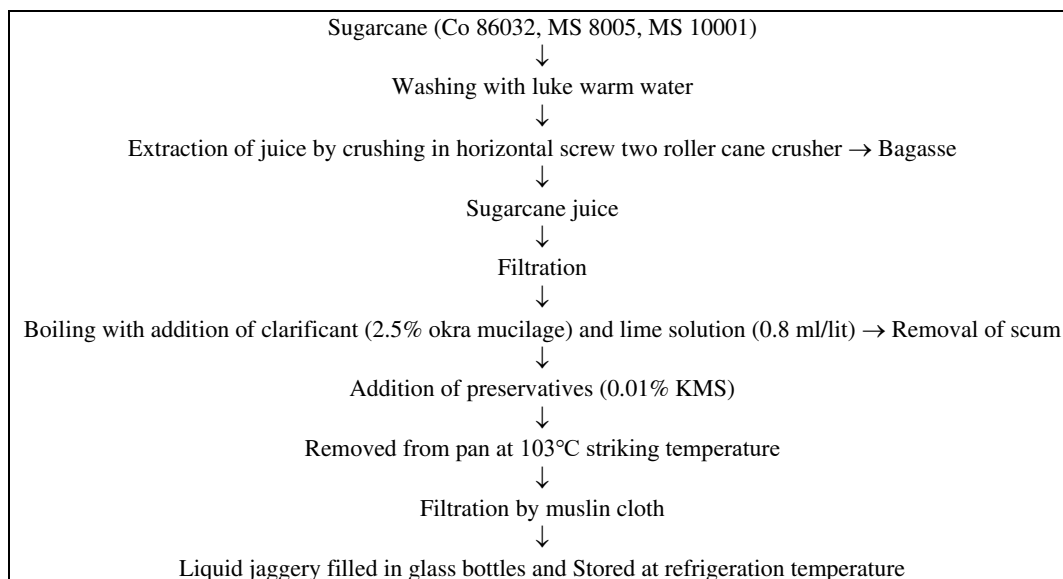


Fig 1: Flowsheet for Preparation of Liquid Jaggery

Determination of physical properties of liquid jaggery

Yield of liquid jaggery

Percent yield was calculated by using following formula

$$\text{Yield (\%)} = \frac{\text{Weight of liquid jaggery}}{\text{Weight of sugarcane juice}} \times 100$$

Yield of scum

Percent yield was calculated by using following formula

$$\text{Yield (\%)} = \frac{\text{Weight of scum}}{\text{Weight of sugarcane juice}} \times 100$$

Determination of viscosity of liquid jaggery

Viscosity of the sugarcane juice and liquid jaggery was measured in millipascal-second (m-Pa.s)/centipoise (Cp) by using Brookfield Viscometer (Hossain M. and Singh N., 2018) [5].

Determination of specific gravity of liquid jaggery

Specific gravity bottle was cleaned, thoroughly dried and the weight was recorded. Specific gravity bottle was filled upto the mark with freshly boiled and cooled distilled water maintained at 27±10°C and weighed. The procedure was repeated liquid jaggery samples maintained at the same temperature (Chikkappaiah L. *et al.*, 2017) [3].

Determination of chemical properties of liquid jaggery

Determination of pH

pH was measured according to Rangana S. (1986) [13], using a digital pH meter.

Determination of Total Soluble Solids (TSS)

A hand held refractometer with 0 to 90° Brix scale was used for TSS measurement (Patil S. and Anekar S., 2014) [10].

Total titrable acidity

It was determined by titrating a known weight of liquid jaggery with 0.1N NaOH solution using phenolphthalein as an indicator. The results were expressed as percent anhydrous citric acid (w/w) (Ranganna S., 1994) [14].

Reducing Sugar

The reducing sugars in liquid jaggery samples was estimated by DNS method (Miller G., 1959) [9]. To 1 ml of sample, 3 ml of DNS reagent was added and incubated in boiling water bath for 5 min. The colour developed was read at 575 nm. The standard graph of glucose was prepared using glucose as the standard in the range of 0-30 mg concentration from 100 mg/ml stock solution. A standard graph was plotted with absorbance at 575 nm against concentration of glucose. A blank was also prepared in the same way (0 mg glucose). The amount of reducing sugars was expressed in percentage.

Total reducing sugar

Total reducing sugar was determined by phenol-sulphuric acid method (Dubois M. *et al.*, 1956) [4]. To 1 ml of sample, 1 ml 5% (w/v) phenol and 5 ml con. sulphuric acid was added. The sample tubes were kept in ice while adding sulphuric acid. The mixture was incubated at room temperature for 20 min and the absorbance was read at 490 nm. The standard curve of Glucose was prepared using glucose as the standard and plotted against absorbance. A blank was also prepared in the same way (0 mg glucose). The amount of total reducing sugars determined was expressed as percentage on dry weight basis.

Non-reducing sugar (sucrose)

Sucrose percent was calculated from the difference between total reducing sugar (TRS) and the free reducing sugar (FRS) or glucose (Mandal D. *et al.*, 2006) [7].

$$\text{Sucrose} = (\text{TRS} - \text{FRS}) \times 0.95$$

Determination of proximate composition**Determination of moisture content**

The moisture content of the liquid jaggery was estimated by oven-drying method as per the procedure given by Ranganna S., 1994 [14].

Determination of protein content

Protein content was determined by Micro-kjeldhal method (AOAC, 1990) [1].

Determination of fat content

Crude fat content of sample was determined by using Soxhlet Apparatus (AOAC, 1990) [1].

Determination of total ash content

Total ash was estimated by incineration and drying in a muffle furnace at 550-600°C as per the procedure given by Ranganna S., 1994 [14].

Determination of crude fiber content

The crude fiber was determined as per the method given by (AOAC, 1990) [1].

Determination of carbohydrate content

Carbohydrate were calculated by difference method as follows

$$\% \text{ Carbohydrate} = 100 - \% (\text{moisture} + \text{fat} + \text{protein} + \text{ash} + \text{crude fiber})$$

Determination of mineral content

Minerals like calcium, phosphorus, magnesium, iron, zinc and copper were determined by using titration and spectrophotometric method (AOAC, 1990) [1].

Results and Discussion**Physical properties of liquid jaggery prepared from different sugarcane varieties**

Table 1: Physical properties of liquid jaggery prepared from different sugarcane varieties

Sample	Yield of Liquid Jaggery (%)	Yield of scum (%)	Viscosity (Cp)	Specific gravity	Density (gm/cm ³)
Control	19.6	2.60	820.60	1.31	1.45
LV ₁	20.50	2.54	807.33	1.95	1.34
LV ₂	19.2	2.85	790.45	1.93	1.27
LV ₃	18.00	2.97	782.98	1.21	1.25
SE±	0.270	0.014	0.490	0.002	0.015
CD at 5%	0.832	0.045	1.511	0.007	0.046

*Each value is average of three determinations

Control= Liquid jaggery market sample

LV₁= Liquid jaggery prepared from Co 86032

LV₂= Liquid jaggery prepared from MS 10001

LV₃= Liquid jaggery prepared from MS 8005

The results from above table revealed that when LV₁, LV₂ and LV₃ compared with each other excluding control sample LV₁ had highest values for percent yield of liquid jaggery (20.50 percent), viscosity (807.33 Cp), specific gravity (1.95) and density (1.34 gm/cm³). Results were in close accordance with Hossain M. and Singh N., (2018). Percent yield of sum i.e. waste made up of waxy materials and insoluble debris was found highest in sample LV₃ (2.97 percent) and lowest in sample LV₁ (2.54 percent).

It was found that there was significant difference in values of viscosity, specific gravity, TSS and density of LV₁, LV₂ and LV₃ because of significant difference in chemical properties of sugarcane juice and affinity of insoluble debris to get removed during preparation stages.

Chemical properties of liquid jaggery prepared from different sugarcane varieties

Table 2: Chemical properties of liquid jaggery prepared from different varieties

Sample	pH	TSS (Bx)	Titration Acidity	Reducing sugar (%)	Nonreducing sugar (%)
Control	5.60	68.59	0.301	16.55	51.48
LV ₁	5.87	68.31	0.299	16.20	51.83
LV ₂	5.89	68.23	0.285	16.47	51.56
LV ₃	5.93	68.12	0.281	17.32	50.71
SE±	0.013	0.039	0.003	0.262	0.265
CD at 5%	0.044	0.118	0.008	0.787	0.798

*Each value is average of three determinations

pH of sample LV₃ was found highest (5.93) and that of control sample was lowest (5.60). Among LV₁, LV₂ and LV₃, sample LV₁ had highest TSS (68.31 ° Bx). Titrable acidity of control sample was highest (0.301) and that of sample LV₃ was lowest (0.281). Reducing sugar content of sample LV₃ was highest (17.32 percent) and that of sample LV₁ lowest (16.20 percent). Non-reducing sugar content was highest in sample LV₁ (51.83 percent) and lowest in sample

LV₃ (50.71 percent). Findings were comparable to Patil S. and Anekar S., (2014)^[10].

It was reported that there was significant difference between values of reducing sugar, non reducing content of liquid jaggery samples might be due to difference in rate of inversion of sucrose into glucose, fructose and dextrins.

Proximate composition of liquid jaggery prepared from different sugarcane varieties

Table 3: Proximate composition of liquid jaggery prepared from different sugarcane varieties (gm/100 gm)

Sample	Moisture	Protein	Fat	Carbohydrate	Crude fiber	Ash
Control	32.40	0.44	0.11	63.31	0.15	3.59
LV ₁	34.36	0.41	0.12	61.42	0.14	3.55
LV ₂	35.60	0.39	0.19	60.17	0.13	3.52
LV ₃	35.84	0.37	0.20	60.01	0.11	3.47
SE±	0.269	0.005	0.004	0.107	0.007	0.014
CD at 5%	0.619	0.016	0.015	0.322	0.050	0.043

*Each value is average of three determinations

Results revealed that values of moisture content significantly varied in control sample and prepared liquid jaggery samples. Moisture content of sample LV₃ was found highest (35.84 percent) and lowest was in control sample (32.40 percent). Liquid jaggery contained less amount of protein and fat. Liquid jaggery was good source of energy, all samples were rich in carbohydrate content. Among prepared liquid jaggery samples LV₁ had highest (61.42 percent) carbohydrate content. Liquid jaggery was high in ash content. Among prepared samples LV₁ contained 3.55

percent of ash. Findings were similar to Pawar D. *et al.*, (2017)^[11].

There was significant difference in values of moisture, carbohydrate, crude fiber and ash content of samples LV₁, LV₂ and LV₃. The reason might be difference in chemical composition of sugarcane juice extracted from different sugarcane varieties.

Mineral composition of liquid jaggery prepared from different sugarcane varieties

Table 4: Mineral composition of liquid jaggery prepared from different sugarcane varieties (mg/100 gm)

Sample	Calcium	Magnesium	Phosphorous	Iron	Zinc	Manganese	Copper
Control	65.03	117.00	40.61	11.01	0.31	0.25	0.15
LV ₁	66.75	116.84	40.93	11.02	0.35	0.27	0.16
LV ₂	65.46	115.30	40.86	10.98	0.33	0.21	0.15
LV ₃	65.39	115.02	40.57	10.87	0.29	0.19	0.14
SE±	0.108	1.360	0.103	0.250	0.006	0.004	0.002
CD at 5%	0.325	4.193	0.310	0.756	0.019	0.014	0.005

*Each value is average of three determinations

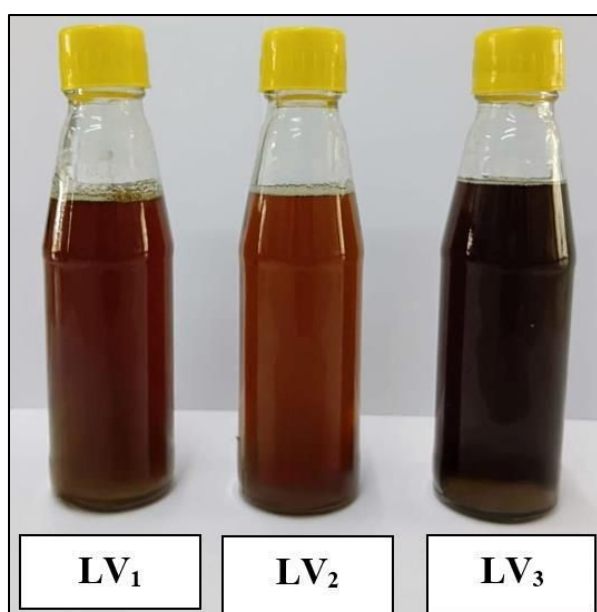


Fig 2: LV₁= Liquid jaggery from Co 86032, LV₂= Liquid jaggery from MS10001, LV₃= Liquid jaggery prepared from MS 8005

Sample LV₁ had highest level of calcium (66.75 mg per 100 gm), phosphorous (40.93 mg per 100 gm), iron (11.02 mg per 100 gm), manganese (0.27 mg per 100 gm) and copper (0.16 mg per 100 gm) respectively. Magnesium content was found highest in control sample (117.00 mg per 100 gm). Results were more or less similar to findings reported by Singh P. *et al.*, (2018)^[18]. It was observed that values of mineral content varied significantly in liquid jaggery samples due to difference in mineral composition of sugarcane juice extracted from different sugarcane varieties.

Conclusion

This study highlights the potential of liquid jaggery as a nutritious and functional sweetener. Among the evaluated sugarcane varieties, liquid jaggery prepared from Co 86032 (LV₁) was superior in yield, viscosity, total soluble solids and non-reducing sugar content. LV₁ also contained the highest levels of essential minerals such as calcium, phosphorus, and iron, making it nutritionally advantageous. The use of 2.5% okra mucilage as a clarificant proved effective in improving the quality of liquid jaggery, supporting its application as a natural alternative to white sugar and honey. These findings emphasize the scope of

liquid jaggery as a sustainable product in the food industry with potential health benefits and versatility for diverse applications.

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