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## Studies on traditional Indian sweetener jaggery processing with selected organic clarifying agents

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#### Abstract

In India, jaggery and Khandsari are popular sweeteners among the rural masses as a traditional sugar product. The jaggery is a good source of minerals, vitamins and molasses. The importance of jaggery is enhanced due to its low cost and high nutritional value. The jaggery contains an enormous wealth of minerals, protein and vitamins inherently present in sugarcane juice and this crowns it as one of the most wholesome and healthy sugars in the world. Jaggery preparation is broadly divided in to four stages such as, extraction of sugarcane juice, clarification of juice, boiling of juice or concentrate and finally modeling according to shape & size. A clarification technique is adopted for the separation of the non-sugar substances from the juice. The clarifying agents used for clarification of sugarcane juice are bhindi, Shukhlai, semal bark and combination of Shukhlai with semal. The best clarifying agent was Shukhlai found followed by Shukhlai and Semal combination, bhindi plant and last optimum clarifying agent was semal bark mucilage.

**Keywords:** hernia, buffalo bull, umbilical, herniorrhaphy

#### Introduction

Sugarcane is the main source of sugar (80%) in the world and known as a predominant cash crop. Most consuming products of sugarcane are sugarcane juice, white sugar, brown sugar, Khandsari and jaggery. Molasses and bagasse is the main by-products of sugarcane industry. Bagasse is mostly used as fuel and paper manufacturing industry and molasses (Sera) is used in liqueur manufacturing distillery for the production of many value added products such as alcohol, ethyl alcohol, butyl alcohol, citric acid etc. Rum is the most consumable liqueur made from molasses. Other used of molasses are as an additive for livestock feeds, manufacturing the small coal bricks as a fuel source in salt industry and other therapeutic treatment. The press mud of jaggery industry is used as a special dietary supplement for pork in winter season and the press mud of sugar industry is known as an agent which improve the soil property, saline and alkaline soil (IISR 2017) <sup>[10]</sup>. A large rural population are totally depends on sugarcane farming such as cultivation, harvesting and other activities (Murthy, 2010) <sup>[11]</sup>.

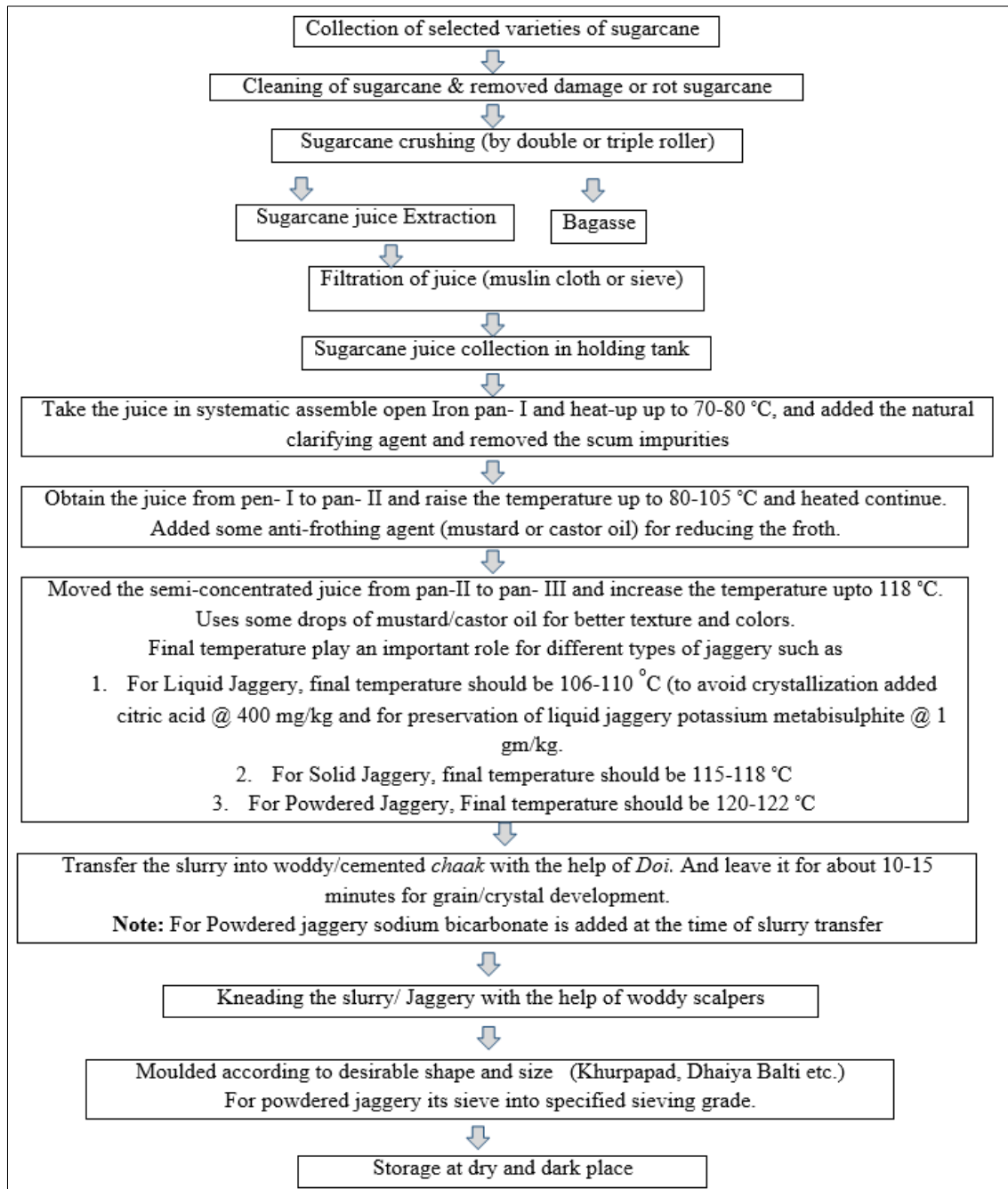
According to current observation the per capita consumption of sugar is 24 kg/person/year. Globally more than 120 countries producing sugarcane as main crops and earned foreign exchange (IISR 2017) <sup>[10]</sup>.

In India jaggery and Khandsari are the traditional sweetener products among the rural areas as main sweetener products, but due to lack of packaging and storage system during the period of rainy season, jaggery and jaggery powder loss their texture and started flow as liquid jaggery, therefore, villagers' makes the other products like Chakke (a combination of wheat flour with jaggery) and manage the textural and organoleptic property of jaggery. Jaggery is the combined packed products of sweetness, minerals, vitamins and molasses. It's available in the market mainly in their three forms like solid, powder and liquid in India according to the consumption and requirement of particular areas. The most important points of jaggery are its low cost and high nutritional value. Jaggery contain most of essential minerals, vitamins, proteins and carbohydrates, more importantly, jaggery have great medicinal and nutritional value because it's investigated that if people consume jaggery daily, then it increase the life span. Jaggery contains 28g/kg of minerals value as against white or refined sugar which contain only 300 mg/kg of minerals. Jaggery contain such micronutrients, which have the anti-toxic, anti-carcinogenic properties, if jaggery consume day to day diet than it can prevent the atmospheric pollution or air pollution related toxicity and prevent the risk of lungs cancer (Rao *et al.*, 2007) <sup>[2]</sup>.

The desirable quality of jaggery is golden-brown to yellow in colour, hard and crystalline in texture, the quality jaggery is influenced by the variety of sugarcane, quality of process, use of clarificants in sugarcane juice and method of processing adopted.

### Material and Method

Sugarcane varieties Co 0238 was selected for jaggery preparation. In jaggery manufacturing mainly four processes are involved (A) Extraction of sugarcane juice (B) Clarification process (C) Concentrate the juice or slurry and (D) Moduling according to size, shape and requirement.



Jaggery manufacturing flow chart

The clarification process is the most important process for jaggery colour and appearance, because the colour of finished product totally depends on clarification process and which types of clarifying agents are applied for this purpose. For the commercial production of jaggery, herbal and chemical clarifying agents are used. In India the production cycle of jaggery, mainly in rural areas, started from October to May. There are three types of jaggery are manufactured from sugarcane juice namely solid, powder and liquid jaggery. But in western Uttar Pradesh, predominantly solid jaggery is produce followed by powdered jaggery. Solid jaggery have

80% portion in all three kinds of jaggery, remaining 20 percent portion included powder & liquid jaggery. Liquid jaggery is an intermediate product of jaggery processing and it obtained at 106-110 °C. Solid jaggery obtained at 115-118 °C and powder jaggery have 120-12 °C.

### Standardization the herbal clarifying agent for jaggery manufacturing

Sugarcane juice recovery at different location of local jaggery manufacturing unit varies from 63.000 to 65.000 kg per 100 kg of sugarcane are presented in Table 1.

**Table 1:** Standardization of clarifying agent activity

Treatment	Mucilage of clarifying agent used (kg)	Clarifying agent specific gravity	scum recovery (kg)	Effect on clarification	Colour of final jaggery products
Shukhlai	2.960 ± 0.100	93.000 ± 0.500	3.800 ± 0.200	Complete clarification	Light yellow to red
bhindi plant	3.150 ± 0.150	95.000 ± 1.000	3.250 ± 0.250	Complete clarification	Dull yellow to red
semal	3.310 ± 0.100	95.500 ± 0.500	3.100 ± 0.100	Complete clarification	Bright red
Shukhlai + semal	3.050 ± 0.100	95.0000 ± 0.500	3.400 ± 0.200	Complete clarification	Yellow bright red

The juice extraction by crushing sugarcane is first step towards jaggery manufacturing. Usually, 2-5 roller crusher is

used for extraction of juice which may be power operated (engine/electric) or animal driven vertical/horizontal crusher.

**Table 2:** To study the processing methods for jaggery production by using organic clarificant

Sr. no.	Parameters	Lab	MU- 1	MU-2	MU-3	Remark
01	Sugarcane juice quantity	10.5	102	227	70	Sugarcane juice filtered through triple layer muslin cloth
02	Initial Temp.	32	29	34	31	
03	Initial Brix	20 °B	19 °B	21 °B	20 °B	
04	Initial specific gravity	105	105	104	105	
05	Juice temperature during Clarifying agent	75 °C	80 °C	73 °C	76 °C	Temperature varies between 70-80 °C
06	Additives (clarifying agent) used	Shukhlai	Shukhlai	Shukhlai	Shukhlai	MU-1 added chemical clarifying agent for improve the texture and colour
07	Specific gravity of clarifying agent	93.5	94	93	93.5	Specific gravity depends on kneading and mixing process
08	Clarifying agent amount	290 gm	2.77 kg	6.67 kg	2.01 kg	
09	Specific gravity after cleaning the juice	102	102	102.5	102	Impurities removed from juice
10	Anti-frothing agent used	Mustard oil	Mustard oil	Castor oil	Castor oil	2-5 ml anti-frothing agents used
11	Final slurry temperature	117.8 °C	118.2 °C	118 °C	117.4 °C	Final temperature of slurry depends on storage of jaggery
12	Final Brix	87 °B	89 °B	88 °B	88 °B	
13	Time for grain development	10-12 min	12-15 min	10-15 min	10-12 min	After grain development time period jaggery slurry kneaded with the help of scalpers
14	Moulded shape	Khurpapad	Khurpapad	Khurpapad/Balti	Khurpapad/Dhaiya	
Lab- Laboratory Work, MU- Manufacturing Unit						

## Result and Discussion

The research work was undertaken to develop a standard of jaggery from sugarcane juice by using herbal clarifying agent. The principle vegetable clarifying agents used clarification of sugarcane juice are *Hibiscus esculentus* (bhindi), *Cadia celcina* (sukalai), *Bombax malabaricum* (semal bark) and combination of Shukhlai with semal. The optimum clarifying agent was Shukhlai followed by Shukhlai and semal combination, bhindi plant and last optimum clarifying agent was semal bark mucilage. The specific gravity of different clarifying agent varies from 92.000 to 95.500 gm weight per 100 ml weight of standard liquid. Maximum specific gravity was measured for semal bark mucilage (95.500) followed by bhindi plant (95.000) mucilage and semal Shukhlai (95.000) mucilage and minimum was measured for Shukhlai (93.000) mucilage.

The quality of extracted mucilage was measured on the basis of lower weight of developed mucilage from mixing of water and clarifying agent. The scum recovery rate was varies from (3.800 kg to 3.100 kg/100 kg) of sugarcane juice. The highest recovery of scum was measured for Shukhlai (3.800) followed by semal Shukhlai (3.400), bhindi plant (3.250) and semal (3.100) kg/100 kg of sugarcane juice. The cleaning process for optimum clarification of sugarcane juice was all

three types of jaggery including solid, powder and liquid jaggery. Shukhlai was found the best clarifying agent on the basis of colour and texture of finished products. These both attribute are the main factor for consumer acceptability.

## Recovery of different parameters in jaggery production

Mostly sugar mill or jaggery manufacturing units are operated for November to May. Sweetness of sugarcane juice is the main factor which influences the recovery of jaggery/sugar. The brix percentage of sugarcane juice was varied from (19.600 to 26.8000 B). Highest brix percentage was measured in May (26.800) month or at the last of jaggery season followed by March (23.300), January (20.300) and November (19.600) degree brix percentage are presented in Table 3. Sugarcane variety (Co 0238) was predominantly cultivated in western Uttar Pradesh and all jaggery samples were collected of this variety. Bagasse recovery was proportionally observed with sugarcane juice recovery; on an average the bagasse recovery was observed (36.000 ± 1.000). Jaggery recovery was observed (11.67 to 13.467) solid jaggery, (11.533 to 13.117) powder jaggery and liquid jaggery was observed (24.617 to 27.667) kg/100 kg sugarcane Sarwar *et al.*, (2009) support the final result.

**Table 3:** Recovery of different parameters from sugarcane

Month	Brix percentage	Solid Jaggery recovery	Powder jaggery recovery	Liquid jaggery recovery
November	19.600 ± 0.200	11.677 ± 0.025	11.533 ± 0.029	24.617 ± 0.407
January	20.300 ± 0.200	12.167 ± 0.029	12.150 ± 0.050	25.533 ± 0.284
March	23.300 ± 0.100	12.900 ± 0.100	12.383 ± 0.126	26.467 ± 0.252
May	26.800 ± 0.200	13.467 ± 0.058	13.117 ± 0.076	27.667 ± 0.252

### Summery and Conclusion

In case of individual clarifying agent Shukhlai was found the best clarifying agent. Shukhlai consumption observed (2.960) kg/ 100 kg of sugarcane, specific gravity of Shukhlai solution (93.000) gm/100gm weight of standard solution, scum recovery (3.800) kg/100 kg of sugarcane, recovery of sugarcane juice & bagasse (64.000 ±1) kg/100 kg sugarcane and (36.000 ±1) kg/100 kg sugarcane (Co 0238) respectively. Jaggery recovery was found for solid jaggery (11.67 to 13.467), powder jaggery (11.533 to 13.117) and liquid jaggery (24.617 to 27.667) kg/100 kg sugarcane. Attributes which fluctuate the recovery rate of jaggery, may be variety of sugarcane, sugarcane cultivation area and procedure applying for production. The study will be useful in future for the researchers whose works in the field of jaggery production and application of different herbal clarifying agent in jaggery processing.

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