

A Case Study of Jaggery Production at Akbarpur Ambedkarnagar

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Abstract – Sugarcane is an important cash crop in Indian agriculture. Sugarcane is mainly cropped for the production of Sugar, but it is also used in the production of Jaggery, Khandsari. In this health conscious era where healthy food is preferred over normal food, Jaggery plays an important role. More than 70% of Jaggery is produced in India and that day is not so far when it creates a huge revolution better than sugar. Jaggery is the natural sweetener which is prepared by sugarcane juice. It is available in solid, liquid and powder form. It is also called as Non Centrifugal Sugar (NCS) and is known by many different names in the world like Panela, Kokutu, Muscovada, and Gur. The sap collected from some palm trees such as palmyra-palm (*Borassus flabellifer*), coconut palm (*Cocos nucifera* L.), and wild date palm (*Phoenix sylvestris* Roxb). The methods of converting sugarcane and manufacturing sugar, gur and khandsari were different but a great value was added in the manufacturing of these consumable final products. The micronutrients which were present in Jaggery had much nutritional and medicinal aspect like its anti-carcinogenic and antitoxic activity. Jaggery had proved itself better as it compared to white sugar. Jaggery was known to produce heat and give instant energy to a human body. The composition of jaggery was found sugar 60-85%, glucose, fructose 5-15% and protein 0.4%, moisture 5-10% etc.

Keywords – Gur, Jaggery, Khandsari, Sugarcane.

I. INTRODUCTION

India is the largest consumer and the second largest producer of sugar in the world. Sugar industry is the second largest organized sector industry in the country. Among the sugar yielding crops sugarcane, sugar beet, palms and sorghum, sugarcane is the most important. Presently, sugarcane is cultivated in an area of about 4.361 million hectares producing about 281.575 m tones of sugarcane annually. This sugarcane is used in the manufacturing of Jaggery, Sugar and Khandsari etc.

Jaggery is a traditional non-centrifugal sugar consumed in Asia and Africa. These sugars are a concentrated product of the cane juice without separation of the molasses and crystals. Non-centrifugal sugar is actually, is the technical name of the product obtained by evaporating the water in sugarcane juice, and is known by many different names in the world such as Gur (India), Kokuto (Japan), Panela (Latin America). These traditional sweeteners are natural mixture of sugar and molasses. If pure clarified sugarcane juice is boiled, what is left (usually 65-85% sucrose) as solid is Jaggery. In India sugarcane produced, 53% is processed into white sugar, 36% into Jaggery and Khandsari, 3% for chewing as cane juice, and 8% as seed cane.

As the major producer of Jaggery, the country has recognized as one of the leading traders and exporters of Jaggery to the world. India exported 2, 92,212.03 MT of Jaggery and confectionery products to the world for the worth of Rs. 1,289.26 crores during the year 2015-16.

II. MATERIALS AND METHODS

2.1. Preparation of Jaggery

At primary stage it is important to choose the preferable species of sugarcane crop for the production of Jaggery. The suitable species for the production of jaggery may consist of following parameters-

- Soft and less fibers.
- Medium thickness.
- Less minerals in juice.
- High presence of sugar.
- High productivity.

There are various types of species used in India, in accordance of their climate. The preferable species used in Uttar Pradesh are as follows- HSF-240, CPHS-35, Ko. Sha 8436, Ko Se 03234, Birendra, Ko. Luck 94184 etc.

2.2. Prevention of Sugar Losses after the Harvesting of Sugarcane

Sugarcane is cropped over 5 million hectare area in India, in which almost 50 percent of area belongs to subtropical region which is suitable for the crop growth, but rank of India in world is relatively less with respect to the climate and area cropped. There are following reasons which are responsible for the sugar losses in sugarcane-

- Lack of scientific agriculture practice.
- Long duration between the crushing and harvesting of sugar which causes sound sugar loss.
- Presence of catalyst invertage which actives at the ph of 4.8-5.2 which converts sucrose into glucose and fructose.
- Lack of transportation.
- Diseases and pests.
- Moisture content in sugarcane.
- Bad storage conditions or storage of sugarcane in open.
- Other environmental factors such as temperature, harvesting time, humidity, rain.
- Thus these are the main factors responsible for the sugar loss in sugarcane crop.

2.3. Quality of Cane and Cane Juice in Relation to Jaggery Production

The data revealed a significant difference among strains except acidity, among means for cane and cane juice analysis. These observations are as follows-

Ash-

Excess of ash adversely affects the jaggery quality. A perusal of data embodied in Table I indicated that all means varied non-significantly with respect ash. A highest percentage of ash after standard HSF-240 (3.10%) was shown by strain CP81-1254 (3.06%), while lowest (2.76%) by the strain S98-SP-108 as compare to the standard (HSF-240). Such genetic variation in jaggery ash contents have already been reported (Hussain et al., 2003).

Color-

It is an important physical character of jaggery, because light colored jaggery is preferred. It is evident from the table that there was significant variation among strains for color. S98-SP-108 exhibited lowest colorimetric units before (38.84) and after storage (36.36) as compare to standard HSF-240 (48.25 & 45.43 colorimetric units before & after storage, respectively). Similar results were reported by Uppal and Sharma (1999).

Moisture-

Jaggery with high moisture percentage adversely affects the quality (Singh et al., 1975). Significant differences for moisture percentage among various strains were confirmed (Table II). Lowest percentage of moisture (4.69 & 4.44) was recorded in S98-SP-108 before and after storage as compare to the standard strain that showed maximum value (6.27%) before storage and ranked second (4.90%) after storage. These observations are similar to that reported by Patil et al. (1994a).

Net Rendements-

It shows a combination of all three sugars present in jaggery. The results revealed that strains varied significantly for this parameter of their jaggery (Table II). The maximum values of net rendements before and after storage (57.95% & 56.56%) were shown by strain S2001-US-400, while minimum value (56.40%) before storage was recorded by CP81-1254 and after storage (56.05%) by strain CPHS-35. The remaining three strains fell within this range. These explanations are in agreement with those revealed by Hussain et al. (2003) who reported a trend analogous to this description.

Acidity-

A low pH or high acidity fastens jaggery quality deterioration process by inversion. Regarding the acidity, statistically significant differences were noticed between different strains. Lowest acidity before and after storage (5.63 & 5.51) was observed in the jaggery of strain S98-SP-108, while these values were highest in the jaggery of strain HSF-240. An increase of acidity after storage was also noticed in all strains. This demonstration is in harmony with those observed by Patil et al. (1994b).

Sucrose-

Presence of high sucrose contents in jaggery increases its sweetness as well as quality. Minor reduction in sucrose percentage was shown by all strains after storage (Table II). No strain was better than standard HSF-240 as it showed the highest sucrose percentage (73.77% & 73.49% before & after storage, respectively), while strains CPHS-35 and CP81-1254 were similar with respect to their means before and after storage as described by Uppal and Sharma (1999).

Reducing Sugars-

Reducing sugars are already present in jaggery as well as produced by the process of sucrose inversion due to high acidity. Significant differences in the reducing sugars concentration were observed in all. The minimum amount of these sugars was analyzed in jaggery of strain S98-SP-108 before and after storage and it was statistically at par with S2001-US-400. While maximum reducing sugars 6.05% and 6.94%, before and after storage, respectively were recorded in standard HSF-240.

Table I. Quality of cane and cane juice in relation to Jaggery production

Cane Strain	Properties					
	Juice	Pol	Purity	Jaggery	Ash	Acidity
HSF-240	60.56	19.17	81.42	22.45	0.51	5.14
CPHS-35	54.24	16.19	82.32	18.12	0.42	5.31
Birendra	53.29	17.04	82.74	19.03	0.45	5.21
Ko L94184	52.09	15.56	82.25	20.39	0.41	5.13

Strain HSF-240 showed highest Jaggery percent juice (22.45%), jaggery percent cane (13.61%) and sucrose (73.77 to 73.49%). Strain CPHS-35 ranked second with respect to these qualitative and quantitative characteristics. So the strains HSF-240 and CPHS-35 have the potential for quality Jaggery production.

2.4. Machines and Equipments-

The present study was conducted of production of Jaggery is done at ICAR-IISR Lucknow in the year 2015-16. IISR has developed various types of machines for the preparation of jaggery.

Crushers-

Crushers are used to extract sugarcane juice from the sugarcane. There are various types of crushers are used for the extraction of juice-

Vertical Sugarcane Crusher-

Vertical crusher is consist of 3 rollers, placed vertically to each other which is used to press the sugarcane to extract the juice. It works at the speed of 11-22 rpm and contains the power of 10 HP. It crushes 7 quintal sugarcane in an hour.

3. Roller Horizontal Sugarcane Crusher-

3 Roller Horizontal crusher is also consist of 3 rollers but the rollers are placed horizontally. It works at the speed of 7 rpm, containing 10 HP power. The rate of crushing of sugarcane in this kind of crusher is 10 quintal per hour.

4. Roller Small Cane Crusher-

4 Roller small cane crusher is used for the crushing of small size sugarcane. This type of crusher consist of 4 rollers and runs at the speed of 11-12 rpm and contains the power of 10 HP.

Furnace

Usually 2 pan furnaces are used in the evaporation of water from the sugarcane juice but IISR developed a new 3 pan furnace in which the evaporation of water is quite easy and less time taking as compare to the 2 pan furnaces.

Furnace consist of following parts enumerated below-

1. Pans-

It is made by Iron sheet. It is round shaped having the depth of 0.30 meter. The evaporation of juice and preparation of jaggery takes place in the primary or main pan. These all

panns are placed in increasing way like stairs. Each pan has the capacity of 200 liter. The temperature of primary, secondary and tertiary pan is 1200, 200, 100 degree Celsius respectively.

2. Chimney-

It is a cylindrical structure to remove the smoke of fuel after combustion. The circumference of upper side of the chimney is 1.65 m and 1.10 meter at the lower side.

3. Air Pipe-

It starts from the outer side of chimney to the combustion room to provide aeration in the room.

4. Hole for the Fuel-

This hole is used to provide fuel to the furnace for the evaporation of the water from the use.

5. Forced Draft System-

It consists of blower, stand and pipe which is used for sending the air into the combustion chamber.

Thus these are the main machinery used in the production of Jaggery.

2.5. Description of Sequence Operation

Preparation of Jaggery consist of following sequence operations-

1. Storage-

The sugarcane is harvested and properly stored and prepared for the extraction of juice for the preparation of jaggery. To prevent the sugar losses during storage is very necessary.

2. Cleaning-

The dirt and foreign materials should be cleaned before the crushing of sugarcane to prevent dirt or pollutants in juice.

3. Crushing-

The term crushing stand for the process of extracting juice from the sugarcane. There are various types of machines (crushers) are used for the extraction of juice.

4. Purification of Juice-

Purification of sugarcane juice has been done by the help of various natural and chemical purifiers. Some important natural and chemical purifiers are as follows-

Natural purifiers- Devla, soya bean, pea nuts, samel.

Chemical purifiers- Hidrose, Calcium Oxide, sodium carbonate, super phosphate.

5. Evaporation of Water-

It is very important step of preparation of Jaggery. In this step sugarcane juice is heated up to 1200 degree Celsius for to 45 minutes to 1 hour 30 minutes. Hence water is evaporated and Jaggery is founded at the surface of the pan.

6. Molding-

Molding of Jaggery is done with the help of various frames with respect to desired size and shape. Concentrated jaggery is spread over the frames and left for the solidifying.

7. Solidification-

After setting Jaggery in frames for molding frames we left it in frames for solidification in molding room. It need temperature between 15-18 degree Celsius for solidifying.

8. Packaging-

Packaging of Jaggery is very important to prevent various losses and increase the shelf life of Jaggery. Thus these are the sequence operation of Jaggery Production. These

sequenced operation can be easily understand by the flow chart enumerated on next page.

III. RESULT AND DISCUSSION

3.1. Cost Analysis of Jaggery Production- Plant and Machinery

The product does not require many items of machinery. Keeping in mind the production capacity of 200 tonnes per year the unit will require the following machines. The main plant and machinery required comprise.

- Double roller sugar cane crusher with electrical - 1 nos.
- Storage Tanks - 4 nos.
- Steel pans for boiling - 2 nos.
- Weigh bridge 100 kg. - 1 nos.
- Iron Scrapper with long handle - 4 nos.
- Laboratory Equipment. - 1 set.

The total cost of machinery is estimated to be Rs.1, 72,000/-.

The unit will also require miscellaneous assets such as furniture, fixtures, storage facilities, sealing m/c etc. the total cost of these is estimated to be Rs. 1, 00,000. The power requirement will be 40 HP.

Raw Material and Packing Material

The basic raw material for the unit is good quality full grown matured Sugar Cane. For producing 200 tonnes of jaggery the unit requires 2000 tonnes of sugar cane. The extraction of juice from sugar cane works out to about 45%. There shall not be any problem in availability of proper variety of sugarcane from the cane producing states. Other ingredients like Soda/ Bhindi (Lady's finger) are all locally available. The unit will also require jute gunny bags for packing. The price of raw material and packing material at full capacity utilization is estimated to be Rs. 12.00 lakhs per year. At 60% capacity in 1st year the cost works out to Rs7.20 lakhs.

Land and Building

For smooth operation of the unit, it will require a small plot of land 500 sq. mts with a built up area of 300 sq. mts including storage facility. The same may cost approx. Rs. 6.00 lakhs.

Manpower

For smooth functioning of the unit the requirement of man power is expected to be around 10 persons.

Skilled Workers 4.

Helpers 6.

The annual salary bill is estimated to be around Rs.2.40 lakhs.

Cost of Project	
Particulars	Rs. lakhs
Land & Building	6.00
Plant & Machinery	1.72
Other assets	1.00
Preliminary expenses	1.00
Margin money	0.30
Contingencies	0.75
Total	10.77
Means of Finance	
Promoters Contribution	3.27
Term Loan	7.50
Total	10.77

Profitability: (60% capacity)	
Sales	15.60
Raw material	7.20
Salary	1.60
Utilities	0.60
Repairs & Maintenance	0.03
Stores & Spares	0.04
Selling & Admn expenses	2.15
Depreciation	0.99
Interest on T.L	0.82
Interest on W.C	0.10
Cost of production	13.53
Profit	2.07

Requirement of Working Capital

This is a seasonal activity and sugar cane is available on credit. Main requirement is for post sales for which a lump-sum provision of Rs.1.0 lakhs is made comprising margin of Rs.30,000/-.

Machinery Suppliers

- M/S S P Engg. Works Kanpur
- M/S A M S Engg. Station Road, Patna.
- M/s Siwan foundry, Siwam Bihar.
- M/S Sahayog Steel Fabrications. Bhojraj para, Gondal.
- GM/S Septu India P Ltd. Begampur, Khatola, Gurgaon.

3.2.1. Properties and Quality Measurements of Jaggery

Jaggery (Gur) is a solid material which is made by clean and concentrated sugarcane juice. A quality jaggery is sweet, dotted and golden in colour and can be easily stored for a long period of time. There are following quality measurements of Jaggery. The physical and chemical properties of jaggery is given in following table II-

Physical properties	Colour, taste, tightness, moisture content and porosity.
Chemical properties	Quantity of Sugar and Minerals.

The quality measurement of jaggery is done on the basis of net rudiment or by Khanna & Chakrawarti (1954), which is enumerated below in table III & IV-

Quality measurement of Jaggery on the basis of Net rudiment

Net Rudiment	Grade	Quality
> 65	A1	Excellent
60-65	A1	Gud
45-60	B	Medium
<45	C	Bad

Quality measurements of Jaggery by Khanna and Chakrawarti (1954)

Measurement	A grade	B grade	C grade
Sugar	>70	60-70%	<60%
Net Rudiment	<10%	10-15%	>15%
Moisture	<5%	5-10%	>10%
Porosity	>25%	15-25%	<15%
Colour	<150	150-250	>250
Ashes	<3%	3-4%	>4%

3.3. Composition

Jaggery can vary from golden brown to dark brown in

color and contains up to 50% sucrose, up to 20% invert sugars, moisture content up to 20% and the remainder made up of other insoluble matter such as ash, proteins and bagasse fines. It contains all the vitamins and rich in important minerals. All the available elements in Jaggery per 100 gram are listed below in table 1-

Sr. No.	Element	Quantity (in grams)
1.	Sugar	60-85
2.	Glucose, Fructose	5-15
3.	Protein	0.4
4.	Moisture	5-10
5.	Calcium	8.0
6.	Phosphorus	4.0
7.	Iron	11.00
8.	Sodium	19-30
9.	Vitamin A	0.38
10.	Vitamin B	0.6
11.	Zinc	0.2-0.4
12.	Chloride	0.053
13.	Minerals	0.6-1.00

Total energy is 380-990 Kcal.

3.3. Flow Chart of Jaggery Production-

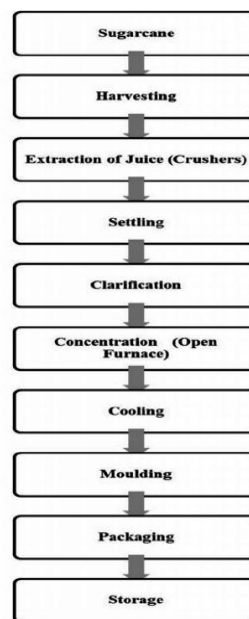


Fig. 1. Process flowchart for solid jaggery production



Fig. 2. Horizontal three roller crushers



Fig. 3. Juice Boiling in open pan



Fig. 4. Wooden moulds

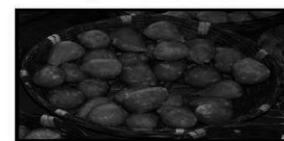


Fig. 5. Solid Jaggery

IV. PACKAGING AND STORAGE

3.4. Life of Jaggery

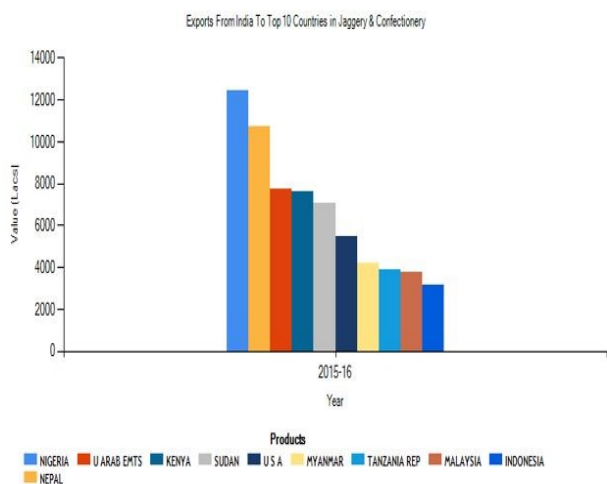
In India, the traditional methods of jaggery storage prevalent in western and eastern regions like open storage, matka, gunny bags etc. Jaggery samples could be stored in cold storage but sometimes it is difficult to store the samples for small scale farmers as cost involved is the main constraint for that. Also the energy consumption is very high. Jaggery from cold storage is used in off-season at high cost. [19] Chand et al. [20] studied the storage behavior of jaggery samples stored under hilly climatic conditions of Utrakhland. Samples were packed in polythene bags, IISR

bins and hanging baskets and stored for a period of five months during which changes in product parameters such as moisture content, sucrose, reducing sugar and colour were determined at an interval of 30 days. The result revealed that good keeping quality of jaggery could be maintained with little changes in sucrose content, colour, total moisture content and reducing sugar under cool hilly climate with IISR drying cum storage bin. Mandal et al. [21] studied the effect of common packing materials on keeping quality of sugarcane Jaggery during monsoon season. In their studies, it was revealed that the best packing material for storing Gur during monsoon season was heat sealed LDPE (Low Density Polyethylene) packet of 150 gauge followed by glass jars. LDPE packets prevented moisture ingress, fall in pH and inversion of sucrose in the stored Gur to the maximum extent.

3.5. Market Potential

The usefulness of Jaggery it has now been recognised at the international level. Kudos to our gur as it has been branded as ‘millennium gur’ and is in great demand in 23 countries, including the USA, Japan, Canada, Hong Kong, Germany, etc. In the recently concluded 88th India science congress in New Delhi, the scientists impressed upon the use of new technology integrating the traditional knowledge in the preparation of gur. This will move India from the green to rainbow revolution. The usefulness of jaggery has been recognized at International level. Now India should concentrate on gur production instead of sugar. Due to heavy competition for food, fibre and oilseeds, there is little scope for increase in the area under sugarcane to meet the increasing demand of gur. Therefore, the only alternative left is to increase the productivity of sugarcane and gur by adopting efficient management practices for sugarcane cultivation.

In this health conscious era where healthy food is preferred over normal food, Jaggery plays an important role. Jaggery has the ability of exportation by which foreign money could be obtained. A farmer can get much profit by the production of a Jaggery. As the major producer of Jaggery, the country has recognized as one of the leading traders and exporters of Jaggery to the world. India exported 2, 92,212.03 MT of jaggery and confectionery products to the world for the worth of Rs. 1,289.26 crores during the year 2015-16.



V. CONCLUSION

“Gur, gur hi raha, chela shakkar ho gaya” goes the old saying but sugar has lagged far behind. Gur has always got respect in Ayurveda. Jaggery industry is growing at a rapid pace. The demand for jaggery is steadily growing in the urban, rural and semi-urban areas. Several applications of jaggery and its use in households makes it a better choice as compared to sugar. It is also cheaper than the sugar. Due to its nutritional & medicinal values it became highly recommendable by the health experts also. Apart from individual households, it is used in large quantities in restaurants, road-side dhabas, other eateries, hostels and clubs and by caterers. In view of its constantly growing market, it should not be difficult for a new entrant to enter and capture the market.

As the major producer of Jaggery, the country has recognized as one of the leading traders and exporters of Jaggery to the world. India exported 2,92,212.03 MT of jaggery and confectionery products to the world for the worth of Rs. 1,289.26 crores during the year 2015-16.

Thus we can say that Jaggery has good exportation ability and medical goodness as well. Production of Jaggery will help the country financially and medically too.

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