CHAPTER - I

INTRODUCTION AND FORMULATION OF PROBLEM

1.1 Brief History :

India leads the world in sugar production. India is also the largest producer of traditional sweetners like jaggery and Khandsari sugar. Some note about sugarcane is observed in Vedic literature such as 'Vajashehi Sanhita','Atherva Veda' etc.

'Megasthinish' who was the Ambassodor of Sallucas Nikator in the ministry of emperor Chandragupta described the jaggery in 40 B.C. as "Jaggery means a stone with pink yellow colour and having sweetness greater than honey". The jaggery, mainly manufactured in different states of India such as Utter Pradesh,Bihar,Maharashtra and Andhra Pradesh. Jaggery is also produced from palm in India. [Marathi Vishwakosh (1977)].

1.2 Brief survey and importance of jaggery :

The production of jaggery is the dominant decentralised cottage industry in cane growing area of different states in India. Inspite of remarkable expansion of sugar industry in the country since 1932, the production of jaggery is still continued as it is used in diet and it has a medicinal value. Also, jaggery is a rich source of energy. It is cheaper than white sugar.

It provides employment in rural area.

Jaggery is an important item of the Indian diet. It is used for different purposes such as direct consumption by human being, stock feeding and in milk, tea or coffee as an excellent sweetening agent and also used in innumerable palatable dishes.

About 10.3 million tonnes of jaggery is produced annualy in india. It meets about 40% demand of sweetners in the country. Only 3000 to 4000 tonnes jaggery valued about Rs.10 million is exported to several countries every year. [Dorge (1994)]. Efforts are being made world over to find alternative to sucrose, which has caused alarming concern about health hazards. Jaggery produced in solid, liquid or powder form has never been reported to possess any health hazards. It is known as ecofriendly nutritive sweetner. Semiliquid jaggery which goes by the name '<u>Kakavi</u>' locally, is an intermediate product obtained during jaggery making process. It has high nutritive value. Its appearence is like jams or honey. Generally <u>Kakavi</u> contains water, sugars and non-sugars. The non-sugars consists of organic minerals viz. protein, amino acids, citric acids, phonolic bodies, gums, pigments and salts of calcium, iron, potassium, magnesium etc. It has

medicinal value being advocated to jaundice patients. [Rajvanshi(1993)].

Jaggery is prepared in different shapes and sizes in solid form and supplied to markets in various parts of the country. In Andhra Pradesh it is prepared in the form of buckets (12-14Kg) and in earthen pots (1-10Kg). Jaggery powder appears like sugar with crystals. Jaggery in powder form is easy for consumption without the need for scraping the jaggery in solid form at the time of utilization. The storage losses which generally occur from 20.4% can be reduced. Jaggery powder has more nutritive value than sugar. Jaggery consists of glucose, fructose (10-15%), protein (0.25%), fats (0.05%), calcuim (0.4%), Phosphate (0.05%), iron (11.0mg/100gm jaggery), copper (0.8mg/100gm jaggery) which are not found in sugar. [Ramkrishna (1994)].

Jaggery is known as 'Gur' in North India and 'Vellum' or 'Bella' in South India . It has also certain medicinal properties as a blood purifier, antidote for rhoumatic ailments and liver disorder. It is also used to prevent oxidative rancidity of fats as it contains natural antioxidant. [Subharwall (1994)].

1.3 Quality of Jaggery :

The quality of jaggery is generally judged by physical characters like colour, structure or texture and sweetness, which determines its marketability. The chemical composition of jaggery determines the durability of jaggery. The chemical composition of jaggery is as under :

i) Non reducing sugars (sucrose)	< 80%
ii) Reducing sugars (glusoce & fructose)	6 to 7%
iii) Minerals (Fe,K,Ca,Ma,S,P etc)	2 to 3%
iv) Pigments like chlorophyll, flavanes	1%
v) Ash, amide nitrogen, lime etc	4%

The quality of jaggery is affected by following factors :

i) Traditional process of jaggery making.
ii) Use of clarificants (vegetable and chemical clarificants).
iii) Sugarcane varieties.
iv) Use of pakaging.
v)Pre-harvesting technology.
vi)Post-harvesting technology of sugarcane.
vii) Soil type.
ix) Composition of juice.

In addition the following parameters determine the quality of jaggery.[Agarawal & Ghosh (1986)].

1. Colour :

Colour is most important quality character for good marketability of jaggery. Golden yellow colour is always preferred. The colour intensity and moisture content increases drastically under storage conditions and jaggery becomes darker in colour [Agarawad & Ghosh(1983)].

2. Texture :

It is important factor for determining the quality of jaggery. The texture may be crystalline or amorphous, while crystalline jaggery is preferred for direct consumption, the amorphous type is preferred for preparing confectionery. The process of moisture absorption and inversion are accompanied by gradual fermentation which imparts unpleasant taste and smell to the jaggery. and due to this, texture is adversely affected. As such jaggery looses its crystalline nature and becoming soft and sticky. [Agarawal(1986)].

3. Hardness :

It is also one of the physical character which is used to determine quality of jaggery. Quality of jaggery depends upon hardness. In general ,hard jaggery posses more keeping quality. The hardness of jaggery is determined by specially designed IISR - Jaggery hardness Tester. (Kg/cm). The ratings are though not fixed, higher readings are preferred for better quality. Hardness measurement is carried out as follows.

i) Take three jaggery blocks for each sample.
ii) Take three readings for each block.
iii) Take reciprocal of 9 readings.

The distance penetrated by the nail attached to a 100gm cylindrical weight when droped from a height of 50cm in a vertical tube was taken as hardness of jaggery. [Agarwal (1983)].

1.4 Recent Practices in Technology of Jaggery and Khandsari :

1.4.1 Introduction :

Jaggery and Khandsari are natural sugars than white sugar produced on large scale in modern plants.

Sugarcane is utilised mainly for the production of jaggery, Khandsari sugar and white sugar. A small quantity is used for chewing, feeding and as a seeds for planting. Reddy and Krishna (1978) studied the pattern of utilization of sugarcane during 1975-76 and is shown in table 1.1. It is noted that 58% of sugarcane was used for jaggery and khandsari as against 29.3% for the production of crystal sugar. Table 1.2 gives data on production of white sugar, jaggery and Khandsari. It is seen that, the production increases gradually but afterwards it is stagnated at about 90 lakh tonnes per annum. On the other hand the production of white sugar increased over four fold during the last three decades. The current use pattern of cane is reported to have changed to about 40% for jaggery and khandsari, and about 45% for white sugar.

A study by de Haan (1988) has indicated the existance of about 1800 khandsari units in India of which 1083 were installed in U.P. The current producion of khandsari sugar is placed at about 12.5 lakh tonnes which is of the same order of magnitude as in 1975-76.

In terms of per capita consumption during 1975-76, it was 6.0Kg for sugar and 11.0Kg for jaggery and

Khandsari. The recent per capita consumption during 1992-93 is 13.6Kg for sugar and 11.4Kg for jaggery and khandsari. The total per capita consumption of sugar, jaggery and khandsari is 25.0Kg per annum. [Anonymous (1995)]. Thus there is growing preference for white sugar.

Five distinct stages may be indicated for processing of sugarcane. They are as follows :

i) Extraction of juice from sugarcane.

ii) Clarification of juice.

iii) Evaporation of juice into massecuite.

iv) Crystallisation of massecuite.

v) Seperation of molasses from sugar.

Crystallisation and seperation of molasses is not practiced for jaggery production. The juice is extracted by crushing the sugarcane between rotating grooved rollers. The residue is called bagass which is used as fuel. It can be used for paper industry or as animal feed. The clarified juice is boiled and evaporated to form massecuite, a thick syrup like mass, which starts to crystallise as soon as a critical temperature is reached. After crystallisation the sugar crystals are seperated from the molasses and dried. The molasses is

obtained as another by-product. It is usually used for production of alcohol and a part of animal feed.

The basic principle of sugar production is to recover highest amount of sucrose as contained in stalks of sugarcane. The efficiency of the production process is expressed by the weight of sugar obtained divided by weight of cane processed i.e. recovery rate. The stage of production process where most sucrose gets lost is the extraction of juice from cane [Anonymous (1993)].

1.4. 2. Jaggery :

Jaggery is solidified from clarified cane juice after concentration, which still contain impurities. It is hard and crystalline and its colour ranges from golden yellow to brownish yellow. Its sucrose content varies from 65-85% . The recovery is about 10-12 percent. The traditional vertical crushers driven by a pair of bullocks are replaced by power driven vertical crushers. The larger units employ power driven horizontal crushers with capacity upto 40 TCD. TCD means tonnes of cane crushed per day. For jaggery making the juice is boiled and evaporated in open pans placed on underground furnaceg heated by direct fire with dry bagasse as fuel.

The juice gets concentrated into a thick mass called masssecuite. When it reaches critical temperature, it is removed from the pans and allowed to cool into a solid mass of given size and shape.

Though the average income elasticity is low, it is difficult to assess to what extent jaggery will be replaced by white sugar in future. As long as the income elasticity of low income group is positive and poverty persists, there will be sufficiently large demand for jaggery. [James (1980)].

1.4.3. Khandsari Sugar :

Khandsari sugar is a finely granulated, crystallised sugar which contains 94 to 98% sucorse. The recovery of traditional process varies between 4.5% & 5.5% where as the semi-modernised process attains rate of 6.5% to 7.5%. [Gehlawant (1994)].

The traditional process, which still uses the vegetable clarification methods, is prevalent in the smaller units. Usually traditional Khandsari is produced together with jaggery in the same plant. The difference is that the molasses is seperated from the sugar crystals

by centrifuging the massecuite. The juice is less concentrated than in jaggery making. The tiny units use hand driven centrifugals and the 'rab' is often crystallised without stirring.

The improved process, commonly denoted by the open pan sulphitation method (OPS). The following flowchart illustrates the open pan sulphitation process. In this process, before boiling, the juice is clarified by means of liming and sulphitation. The first quality OPS sugar can hardly be distinguished from white sugar produced by sugar mills. In large units several operations are mechanised. The molasses left after seperating the sugar crystals is reboiled, crystallised and centrifuged again, and the same is also normally done for the molasses obtained after the second round. Thus three types of sugars are produced. [Anonymous (1959)]. The quality declining with each subsequent round. It is estimated that the OPS sector uses less than 10% of the total cane production.

1.4.4. White Sugar :

The sugar produced by sugar mills is officially called as plantation white sugar. It has a sucrose

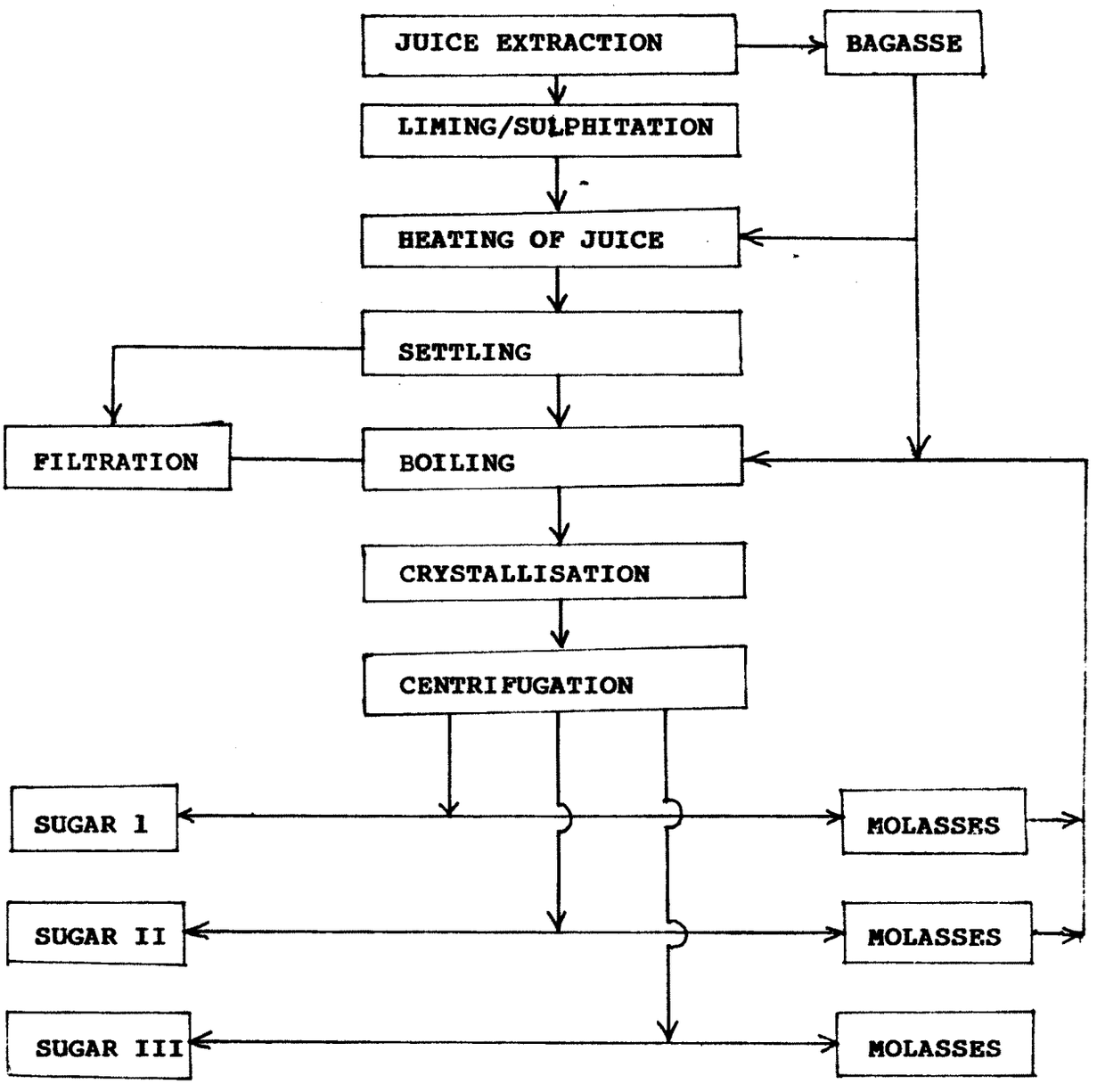

Fig.[1.1] The open pan sulphitation process.

content of 99.5% and recovery rate varies from 8 to 13% depending on the sucrose content in cane juice and the milling efficiency of the factory. In factory, vacuum pan sulphitation (VPS) method is used . The advantage of using vacuum pans is the reduction of inversion. Inversion increases rapidly as the boiling temperature exceed 60^{o} C. At present, the capacity of sugar mills varies from 1250 to 10,000 TCD. [Gehlwant(1994)].

The traditional products, jaggery and khandsari are produced by traditional or semi-traditional techniques on small scale. Sulphur khandsari is produced by OPS process on an intermediate scale and white sugar on large scale by VPS method. All these units located in close proximity with each other and compete directly for their raw material, sugarcane.

1.5 Outline of the present work :

In jaggery and khandsari plants juice is boiled, evaporated and concentrated on open pan furnaces heated by direct fire by burning dry bagasse. The furnace design is improved Chimani Chulhan. The method of juice evaporation is crude and most operations are carried out manually. The manpower is usually self trained and may

lack basic understanding of the manufacturing principles. Thus inspite of large scale production of jaggery and vast export potential, our methods of manufacture of this irrprotant commodity still needed improvement to increase production and avoid losses in processing by adopting advanced package of practices in manufacturing operation in jaggery making. In traditional method of jaggery manufacturing a skilled person known as 'Gulvaya' plays the deciding role in confirming formation of Kakavi and jaggery. It has been observed that slight variation in 'Gulvaya's judgement adversly affect the quality of jaggery and finally affecting in low price in market.

There is no instrumental control in jaggery making. Modern electronics had made an impact on every walk of our day to day life.

In the present work, we have done a comparative studies on jaggery manufacturing units in Kolhapur and Satara regions by considering physical paramenters like temperature and Brix. From the results of our survey we found that, the temperature plays an important role in jaggery manufacturing process. This parameter can be easily sense electronically. Hence we have developed an electronic device, that can give us correct idea about

Kakavi stage as well as final striking stage. (Golli stage). This device has been successfully tested at all the units under survey and it has resulted in giving us correct indication of Kakavi and jaggery stages. Thus one can avoid manual error in jaggery manufacturing process by using most efficient and accurate electronic device which altimately results in improving the quality of jaggery.

Table 1.1 : Utilization of sugarcane (1975-76)

Purpose	Quantity Lakh tonnes	Percent Share
Production of jaggery	654.51	57.87%
Production of Khandsari	184.02	12.93%
Production of VPS sugar	418.50	29.33%
Feeding,Chewing etc	169.42	11.87%
Total production	1427.05	100.00%

Table 1.2 : Production of white sugar, jaggery and khandsari

Year/ product	1960-61	1970-71	1975-76	1980-81	1990-91
Jaggery Khandsari	67.00	74.00	77.00	86.00	84.00
White Sugar(VSP)	30.00	37.00	43.00	52.00	120.00

Source : Ref[Baboo,B & Bajpai (1990)]

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