CHAPTER - II

GENERAL METHODS OF JAGGERY MANUFACTURING

This Chapter describes general methods of jaggery manufacturing alongwith the factors affecting quality of jaggery and grading of jaggery

In this chapter, we have reviewed the pertinent research on some of the aspects which affect quality of juice and jaggery. The general method of jaggery manufacturing is also explained.

2.1 Chemical composition of juice :

The chemical composition of jaggery depends upon the composition of juice from which jaggery is prepared which in turn depends upon number of factors such as soil, climate, variety, stage of maturity, method of jaggery making and environmental factors like humidity and temperature [Kale et. al. (1964); Roy (1951); U.lal et. al. (1994)]. The hygroscopic salts present in jaggery absorb mositure and the deterioration results. In the cane main constituents is sucrose and reducing sugars. It shows a greatest difference in sucrose and reducing sugars. It shows a greatest difference in healthy and matured cane. The chemical composition of cane juice and jaggery is hown in Table 2.1. Jaggery prepared from immature cane is of poor quality and had low recovery [Rege et. al. (1954)]. The mature cane has low nitrogen and high potash [Humbert (1968)]. Whearas an immature cane has high nitrogen and low potash. The high content of nitrogenous substances are difficult to remove during purification of juice and many a times they are left in final products.

imparting darker colour, low recovery and as such jaggery does not keep well. Thus the juice from matured cane is must for obtaining quality jaggery.

2.2 Soil Type :

A variety of cane grown on six soil types gave juices of different qualities [Kadrekar(1957)]. Thus the quality of jaggery depends upon the soil on which the cane is grown. Due to saline soil, cane absorbs more salts in juice. Jaggery prepared from such cane is salty in taste. This type of jaggery tends to run under high humid conditions and also enhances inversion [Ranadive (1976)]. Sugarcane grown on phosphate deficient soils has high phenolic bodies. High content of phenolic bodies are resulting in low quality jaggery [U.lal et.al. (1994)].

Havangi et. al.(1957) found general response of cane yield to phosphate application in soils having less than 0.005% available P_2O_5 While more than 0.01% was found sufficient. But no beneficial effect on sucrose content of sugarcane was observed. According to them soil containing high P_2O_5 and application of phosphate to soil deficient in phosphate brought about early maturity. Soil conditions and other environmental factors including

agricultural practices have their own effect. The cane variety co-419 on six different soil types produced different composition of Juice [Kadrekar (1957)].

The quality of juice samples collected from different regions of Maharashtra indicated that, the juice collected from Kolhapur region was of good quality. It was low in ash, lime, organic non-sugars , amide nitrogen and high in phosphate, iron and magnesium. The juice samples collected from Shrirampur and Kopergaon region were of poor quality. These were high in ash, lime potash and total nitrogen and low in phosphate and albuminoidal nitrogen [Dangre(1963)].

2.3 Manurial Practices :

Manurial practice is important for quality jaggery . Sugarcane that has attained proper maturity with castor cake adversely affects the quality of jaggery [Ranadive(1976)]. Application of molasses however has beneficial effect on jaggery quality [Dakhindas et. al. (1961)]. Heavy application of nitrogenous fertilizers has deletereous effect on the quality of jaggery as juice of such sugarcane has high quantities of total nitrogen and glucose which imparts undersirable red colour and does not keep well [Shrinivas et. al. (1966)]. Adverse effects

of high nitrogenous fertilizers can be avoided by controlling the desired N/P_2O_5 ratio by applying high doses of phosphatic fertilizers [Chitale (1956)].

Manuring sugarcane with superphosphate fastened the maturity by about six weeks and did not have any effect on Brix and purity of juice. It was also observed that phosphate application increased the uptakes of phosphate in juice and decreased nitrogen uptake and there by maintained a proper ratio of N/P_2O_5 (less than 1.5) resulting a good quality of jaggery.

Jadhave H.D et. al.(1994) have reported that, nitrogen dose beyond optimum adversly affects the juice quality. According to them the lower dose of nitrogen with recommended dose of P_2O_5 and K_2O at the rate of 115kg/ha. is found to be beneficial for preparation of quality jaggery and its storability . Also it would be seen that moisture content of jaggery found to increase with the increase in level of nitrogen from 150 to 250kg/ha. During storage the application of lower doses of nitrogen have shown less moisture content as compared to higher doses. Similarly lower doses nitrogen have shown low reducing sugars and high non-reducing sugars. The P^H of jaggery decreased and colour intensity

increased with increased application nitrogen from 150 to 250 Kg/ha. The higher levels decreased the sugar content in jaggery [Dangre (1963)].

Application of phosphorus did not result in higher phosphorus content of sugarcane leaf, but it was found to increase the salt content of the juice. It was observed that application of nitrogen resulted in higher uptake of nitrogen and lime by the cane but showed a depressing effects on the silica and potash content of the leaf tissue. While phosphorus slightly interfere with the absorption of nitrogen. Potassium was found to have an antagonistic effect on the calcium uptake. Nitrogen had a deleterious effect on the sucrose content, the differences being particularly conspicious during the earlier part of the crushing season. Phosphorus showed a highly beneficial effect on the phosphate and total mineral content of juice [Ranbir(1960)]. Laxmikantham et. al.(1973) conducted experiments for three seasons at Anakapalle in A.P.(India). The results of experiments indicated that application of 336 Kg P_2O_5 per hectare to co-419 did not respond to sugarcane or sugar yields. Moreover, application of phosphate did not show any interaction with fertilizer nitrogen applied to crop in all the three levels (112, 224 and 336 Kg/ha).

They further noticed that application of P_2O_5 invariably increased the concentration of phosphorus in tissue throughout the crop cycle.

2.4 Sugarcane Varieties :

Sugar varieties play an important role in quality jaggery manufacturing. The trials at Padegaon showed that the cane varieties co-775, co-650 and co-655 gave good quality juices but these varieties had other drawbacks. The released varieties which are best for jaggery are co-775, co-678 and co-1163 [Ranadive (1976)].

Amongst the released varieties Co-419, Co-7219, Co-7527 and Co-671, Co-8014 gave better results for jaggery. Co-8041 gave highest recovery for all the planting dates (9.48 t 11.11%). The highest non-reducing sugars were observed at the age of 10 months crop of co-7704 (67.98%), Co-671 (67.27%), Co-8209 (63.93%) and Co-8014(63.39%) Whereas 12 month age the variety Co-671 recorded highest non-reducing sugar content (83.50%) following by Co-8014 (80.24%) Co-7704 (80.01%) and Co-8209 (79.96%) i.e. these varieties are better for good quality jaggery and will be used for export purpose. The

standard jaggery, should not contain less than 70 to 75% sucrose. These results were reported by Gupta (1972) and Gupta and balyan (1973). The decrease in sucrose content in jaggery during storage may be due to the metabolism of sucrose by the action of micro-organism responsible for deterioration of jaggery [Gupta et.al, (1973)].

2.5 Preparation of jaggery :

The jaggery manufacturing process mainly involves three important operations

a) Extraction of juice.
b) Boiling and purification of juice and
c) Concentration of juice.

a) Extraction of juice :

A fresh cane having lower percentage fibre will naturally give more juice than a dried cane having higher percentage fibre. Cane must be crushed within 48 hours of harvest and early maturity varieties be crushed earlier [U.lal et.al, (1994)]. The juice is extracted by crushing the cane between rotating grooved rollers. The residue is called begasse which is used solely for boiling juice. Kale and Chinchorkar (1964) postulated that the dark

colour jaggery was mainly due to iron and phenolic compounds. The galvanished pan for juice boiling results in jaggery with bright yellow colur. They also postulated that the presence of soluble alkaline salts results in the dark coloured jaggery which was due to caramalising effect in the process of boiling of the juice.

b) Boiling and purification of juice :

After the removal of visible matter by filtering, the juice is passed through a coarse cloth or nylon cloth in boiling pan. Purification of the juice is helped by this boiling. The aim of purification is to make a juice clear as well as to make it light in cclour. For this purpose clarificants are used. The process of clarification aims at removal of the non-sugar impurities, both suspended and dissolved in the juice. Generally two types of clarificants are commonly used.

i) Vegetable clarificants and

ii)Chemical clarificants

i) Vegetable clarificants :

Bhendi(Hibiscus esculentus), Deola(Hibiscus finculneous), Chikani, Katesevari(India silk tree)mucilage

Bark of semal tree (Bomba malabaricum), Bark of phalsa a tree (Grewia asiatica) and Sukhdai (Kydia Calycina) are commonly used vegetable calarificants. Among these clarificants deola and suklai are better than Bjendi, semal and phalsa [Khanna (1954)]. Acqueous solutions of decorticated crushed castor seed, groundnut and soyabean could be used for clarification. The former two gave better quality jaggery than all other vegetable clarificants [kale et. al.(1964)]. Use of 'phalsa' and 'Ambadi' mucilage gave superior jaggery as compared to other organic clarificants. All treatments gave low amount of reducing sugars in jaggery samples. Bhendi mucilage removed maximum amount of scum from juice and produced medium quality jaggery [Vaidya et. al.(1984)]. The organic clarificants viz. goundnut seed milk and soyabean seed milk was as good as hydros in imporving colour of jaggery. Both these clarificants gave crystalline, slightly hard yellow jaggery [Javdekar et. al.(1985)].

ii) Chemical clarificants :

Lime water, sodium carbonate, sodium bicarbonate, sajji, superphosphate & Alum are commonly

used chemical clarificants. They help in solidification of jaggery but impark dark colour. Hydros and superphosphatee showed high acidity and reducing sugars and low non-reducing sugars in jaggery [Javdekar et. al.(1985)]. Neutralization of juice acidity helped in controlling the inversion of non-reducing sugars during preparation and storage of jaggery.

Reaction of the media play an important role in the quality jaggery making. At the first stage the PH of the juice is raised by adding lime to remove maximum impurities in the form of scum. After removal of scum the use of hydros ($Na_2S_2O_4$) as a bleaching agent in jagger making is a common practice. During the manufacturing process it bleaches the juice and produces light golden yellow coloured jaggery. According to the food and adultration Act 1995, the quantity of hydros used should be limitted. Jaggery used for consumption should not contain more than 70PPM SO_2 and corresponding hydros to be used should not be more than 35g per 1000 litre of juice. Now a days people are using large quanity of hydros which may very up to 1kg per 1000 litre of juice.

Bleaching with hydros is a reduction type of reaction and is favoured under acedic condition.

Basic concept of bleaching :

The bleaching with hydros in reduction type of reaction and is brought about as follows.

i) $Na_2 S_2O_4 + H_2O = Na_2SO_3 + SO_2 + 2H$

This 2H (Nascent hydrogen) combines with the colouring matter and brings about bleashing So produced combines with water forming H So further oxidises to H So with the release of nascent hydrogen.

ii) $SO_2 + H_2O = H_2SO_3$

$H_2SO_3 + HO_2 = H_2SO_4 + 2H$

Simillarly $Na_2 So_4$ oxidises to produce $Na_2 So_3$ with the release of nascent hydrogen.

iii) $Na_2SO_3 + H_2O = Na_2SO_4 + 2H$

Cloured matter +2H = Colurless matter.

This reduction type of bleaching is reversible reaction [Marathe et al (1994)].

The concentration of pigments in jaggery samples is affected by PH of juice adjusted during preparation. It is observed that at low PH value the concentration of pigments is low, as PH value were increased, the concentration of pigments also increased. Pigments are mainly flavonal - I, flavonial - II and flavonal.

(C) Concentration of juice :

After removal of the scum during heating and by use of clarificants the juice is heated so as to evaporate water. It takes about two hours and temperature in constant at about 99°c. When temperature reaches about 105°c to 106°c it attains the 'Kakavi' stage. From this stage to final striking stage (Golli stage), sharp rise in reducing sugars was noted [Shinde et. al (1982)]. After kakavi stage there is sharp rise in temperature, and it reches the final stage (Golli or striking stage) at 118°c-121°c. If pan is removed before the striking stage, jaggery gets freenish tinge and if it is overheated i.e. tmperature higher than striking temperature the jaggery becomes red and hard in texture.

2.5 Packaging and Storage of Jaggery :

The jaggery is hygroscopic in nature. Under humid conditions, due to absorption of moisture bacterial decomposition takes place and inversion process induces running of jaggery. The deterioration of jaggery in storage deperrds upon,

i) Composition of product.

ii) Atmospheric condition of the place of storage and

iii) Form and shape of the product.

The main constituents which bring about deterioration are invert sugars and mineral salts which are hygroscopic in nature. The initial moisture content is also one of the factors. It is necessary to take proper care for packing of jaggery blocks. During storage, moisture absorption increases with increasing reducing sugars. Jaggery with high moisture content deteriorate early in the storage and therefore is considered of very low keeping quality as well as poor quality for export. According to Farooque (1960) the optimum moisture level for growth of micro crganisms is between 6 and 7 per cent responsible for deterioration of jaggery. Hardness of jaggery depends largely on moisture content and jaggery with high moisture content deteriorate faster due to which hard jaggery is always preferred [Kundu et. al. (1992)].

For packaging, dark colour polythene or alkathene bag, gunnies helps in improving storability of jaggery (Ad hoc scheme report, 1991). The blocks should be stored in a well ventilated godown on wooden racks.

2.7 Jaggery Grading based on physical and chemical constituents :

The chemical composition and quality of jaggery

produced in the different regions of the country varies widely due to cane varietiees, agro-techniques followed and manufacturing operation adopted. Therefore, Standardisation of quality and chemical composition are very important in marketing of jaggery. The earlier ranges of colour set for grading jaggery under. agricultural marketing advisor's scheme. are subject to personal errors. Ghosh and Agrawal (1983) studied jaggery grading based on physical and chemical constituents. According to them, the criteria chosen for grading jaggery are

1. Colour in solution.
2. Crystal content (texture).
3. Moisture.
4. Sucrose,
5. Reducing sugars.
6. Insoluble impurities and.
7. Sulphur dioxide,

Details of the specifications for the various grades are presented in Table 2.2. Besides special characters listed in Table 2.2, in general, the jaggery should be sweet to taste without sour, salty or objectionable flavour. Normally, the ash content of jaggery is not used as a

criteria for grading. However, the large quantities of ash make it saltish. The upper limit of ash content of all the jaggery for grading purposes should not exceed six percent.

Use of hydros in jaggery manufacture brightens the colour tremendously which is hazaradous to health. As under preventaion of food adulteration rules, the content of sulphur dioxide should fall within 70 ppm.

The above chart of jaggery grading should be used in practice white marketing of jaggery [Agrawal et. al. (1983)].

TABLE 2.1

Chemical composition of cane juice and jaggery.

Sr No	Factors	Juice	Jaggery
1.	Moisture (%)	80-85	3.8
2.	Sucrose (%)	13-18	65-85
3.	Glucose (%)	0.3-1	3-15
4.	Ash %	0.37	2-5
5.	Non sugars (%)	1 carotene 280	(U/100)
6.	Nitrogen (%)	0.0-1.9 Nictonic	Acidl.0mg/100g
7.	Protein (%)	0.02vitamin B20-	mg/100g
8.	Calcium (%)	0.021Iron & copper traces.	
9.	Phosphours (%)	0.032	
10.	p^H	5.8-6.4	

Source : [Humbert (1968)].

Table 2.2

Grading of Jaggery

Quality factor	Tolerance limit for				
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Colour of N/2 Solution	Below 125	125-174	175-274	275-499	Above 500
Texture (crystal percent)	Above 60	Above 60	30-60	30-60	Below 30
Moisture percent	Below 5	Below 5	5-7.4	5-7.4	7.5-10.0
Sucrose per-cent	Above 80	Above 80	70-80	70-80	60-69.9
Reducing Sugars percent	Below 5	Below 5	5-9.9	5-9.9	10-15
Insoluble impurities percent	Below 1	Below 1	1-1.9	2-2.9	3-4
Sulphur dioxide	Below 70ppm	Below 70ppm	Below 70ppm	Below 70ppm	Below 70ppm

Source : [Agrawal (1983)].

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