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## Cooling rates of Jaggery for formation of jaggery moulds

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**Abstract**

Preparation of jaggery from sugarcane juice was an age old process. The juice is concentrated and cooled for the formation of jaggery. During cooling hot syrup was cooled in the wooden box traditional, the temperature changes were observed and same was compared with aluminum box. The formation jaggery mould was observed in wooden box very soon when compared to aluminum box. The hardness was good in wooden box when compared to aluminum box.

**Keywords:** Jaggery, mould, wooden box, aluminum box, hot syrup

**Introduction**

Sugar cultivation is done on around 4 million hectares of land in India and its production has fluctuated between 230-300 million tons in past several years. India is the largest consumer of sugar and second largest producer in the world (Singhal 2004) [2]. During past five decades though sugarcane production has increased around threefold, the sugar recovery has not shown any upward trends (Jagannadha *et al.* 2007) [1]. Production of white sugar and jaggery is widely used in India, but jaggery when compared to white sugar is produced in lesser quantities. Nearly 20-30% of total sugarcane produced in the country is used for manufacture of about 7 million tones jaggery, which is known as most nutritious agent among all sweeteners (Madan *et al.* 2004) [4]. Jaggery is directly consumed by human and is used in animal feed mixture. Jaggery is a natural sweetener made by concentration of sugar juice prepared without any use of chemical (Kishan singh 1985) [6]. It contains the natural goodness of minerals and vitamins inherently present in sugarcane juice and this crown it as one of the most wholesome and healthy sugar in the world (Beguin 1978) [7]. Jaggery is rich in important minerals like salts: 2.8 g/100 grams, whereas only 300 mg/kg is obtained in refined sugar (Shinde *et al.* 1981) [5]. Jaggery is the sugarcane based traditional sweetener. At present 24.5% of the cane produced in India is being utilized for producing jaggery. Jaggery is nutritious and easily available to the rural people. Compared to white sugar, it requires low capital requirement in production and is manufactured at the farmer's individual unit itself (Jagannadha *et al.* 2007) [1]. Jaggery contains many vital vitamins (Provitamin, vitamin A, vitamin B1, vitamin B2, vitamin B5, vitamin B6, vitamin C, vitamin D2, vitamin E, vitamin PP) and minerals, such as calcium, phosphorus, magnesium and potassium. In fact, jaggery has a mineral content approximately 50 times greater than refined sugar and five times more than brown sugar. It is a wholesome sugar and without doubt is rich in the vitally important mineral salts (28 g per kg compared to 0.3 g per kg in refined sugar) (Gopalan *et al.* 1991) [3].

For the preparation of jaggery the juice is extracted from the cane and filtered and boiled to evaporate the water, then cooled (Singh J *et al.* 2011) [8]. Here the cooling of syrup after judging the endpoint is the important step for the formation of solid mould. The cooling of the hot syrup is the important step for the formation of the mould in the jaggery preparation. Cooling of hot syrup in wooden box was aged old process; here the temperature was noticed and compared with similar aluminum box.

The jaggery is being processed from the sugar cane. First sugar cane is crushed and juice is extracted and filtered. Then the juice is boiled for 100°C to 105°C for two and half hours. Until getting required consistency has arrived.

To study the formation of mould the wooden box and an aluminum box is taken. The thermocouples are arranged at 3 different places and average is taken. The observation is made for half an hour and the consistency is checked with texture analyzer.

The wooden box is taken of 5x5x10cm and is sprinkled with water for some time and then concentrated sugar juice at 105°C is being poured into the wooden box. The thermo couple is introduced in three places into the concentrated juice and readings were taken for every minute and the readings are noted.

An aluminum box is taken of 5x5x10cm concentrated sugar juice at 105°C is being poured into the box without any application of water or cooling. The thermo couple is introduced in three places into the concentrated juice and readings were taken for every minute and the readings are noted. After that both are observed under the texture analyzer. After concentration of the juice by boiling, the concentrated juice is poured in wooden box and aluminum box. So a study is been conducted on the cooling rates. Initially to understand the process many constraints were not taken.

The temperatures is noted by the thermocouples For the present study K type 3mm thermocouples of 5 cm length of model number KMTIN-040 is used. The type of data logger used for the experiment is 'Delta T devices DL2' type data logger. The DL2e Logger is a programmable data logging device, capable of taking readings and storing data. The thermocouples are placed at three box each and average temperature was noted.

Texture analysis was carried out as follows: Test mode: Compression, Option: Return to start, Pre test speed: 2 mm per second, Test speed: 10 mm per second, Distance: 3 mm, Trigger force: 10 g, Probe used: P/5 (5 mm), Cell: Heavy duty platform. To test the samples after securing the holed plate into the heavy platform, the position of heavy duty platform was adjusted so that the probe (P/5) was directly above the plate. The hardness of the prepared jaggery was compared to standard jaggery which purchased.

The temperatures were observed shows that the wooden box sprinkled with water have cooled the concentrated syrup much faster than aluminum box. This may be because of the water sprinkled wooden here acts as coolant because of the water evaporated from the wooden box where as in the aluminum box the cooling was not done. Though the temperature has been decreased it may be attributed to the room temperature (38°C and RH 94%). The temperature has been decreased from 105°C to 62.5°C within 25 minutes in wooden box when compared to aluminum box the temperature was reduced to 83°C. The mould formation was normally observed from the first minute. It was formed in within 25 minutes in the wooden box when seen to aluminum box the same temperature was attained after 18 hours. It can referred that the wooden box was cooled by evaporating the water sprinkled on it and showed a cooling effect to cool the hot syrup and have given the quenching effect for the formation of mould for jaggery.

Table showing temperatures (°C) noted in the data logger for every 5minutes.

**Table 1**

| Time in minutes                 | 1     | 5     | 10   | 15   | 20   | 25   |
|---------------------------------|-------|-------|------|------|------|------|
| Wooden box sprinkled with water | 105.4 | 92.8  | 78.3 | 69.3 | 64.9 | 62.5 |
| Aluminum box                    | 105.2 | 101.9 | 94.6 | 90.3 | 86.1 | 83.7 |

The hardness of the control was first observed it was 6.43kgf. The hardness of the prepared jaggery was compared the hardness with control. It was observed 6.27kgf which was taken from the wooden box after 20 min and 6.37kgf for 25 min. The hardness was same with the control. but in the aluminum box the hardness was not seen at 20 and 25

minutes. It was still in the form of slurry. The hardness was observed after the 18 hrs it was 4.75kgf which was not as hard as control. It can be noticed that even after attaining the same temperature in aluminum box the hardness was not attained. So it can be referred that the cooling of the hot jaggery syrup was important for the formation of jaggery mould.

For the formation of mould the hot syrup need to cool quickly, this may be helpful for the design of the jaggery unit.

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