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RESEARCH PAPER

Processing packaging and storage of jaggery from sugarcane

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SUMMARY :

Jaggery is a specific type of sugar popular in India derived from sugarcane juice. A study was conducted to evaluate jaggery quality by packaging jaggery in different material and packaging conditions. The results revealed that, the best packaging material for storing jaggery in ambient atmosphere was triple layered vacuum packaging material followed by double layer and single layer material. The change in total colour, sucrose content, hardness, reducing sugar content, moisture content, porosity and microbial load in jaggery were observed to be very minimum in jaggery packaged under vacuum in triple layer material. Not much variation was observed in the ash content at the end of storage period. Further, the jaggery product stored under the above condition had scored highest values in the sensory evaluation.

KEY WORDS : Packaging, Storage, Jaggery quality

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India is the second largest producer of sugarcane next to Brazil and the jaggery industry is one of the most important cottage industries in India. Jaggery is used for the preparation of traditional foods and many ayurvedic medicines. India exports 1.73 million tonnes of jaggery to countries like Bangladesh, Malaysia, Sri lanka, Saudi Arabia, U.S.A., Indonesia, U.K., Nepal, etc., contributing Rs.217 crores to the Indian economy (Apeda, 2009).

Jaggery is specially beneficial for people who are anemic, cannot eat or tolerate meat, suffering from frequent muscle cramps, tension or soreness, pregnant or experiencing pre-menstrual syndrome (PMS) symptoms and those have eaten too much salt can balance out their diets with jaggery (Jadhav *et al.*, 2005). It is also proved that jaggery is used in the treatment of bronchial or lung infections and research has shown to possibly offset some of the lung damage caused by silicosis.

Although jaggery is known for its healthy sweetness, due to poor or un-hygiene processing practices, it is losing its quality and turning towards the hazardous part in our routine diet and also the improper packaging and storage methods have lead to quality loss. Jaggery is packaged traditionally under different packaging materials like paddy straw, banana leaves, gunny bag, polythene sheet, etc., which possess poor barrier properties against moisture, light, air, etc., leading to spoilage or deterioration of jaggery quality. It has been reported that more than 10% of jaggery produced in the country, worth Rs. 40 crore, is lost every year due to product deterioration (Mandal *et al*., 2006).

Khanna and Chakravarti (1948) conducted studies on storage of jaggery and reported that there was more than 10 per cent loss in sucrose, 50 per cent increase in acidity, 2 per cent increase in the moisture content and 20 to 30 per cent increase in the total colour change in the jaggery stored in open atmosphere between August and October months compared to jaggery stored under closed condition inside the blankets.

Some of the common methods adopted for the jaggery storage are use of earthen pots, over dry leaves or wooden planks in rooms, in gunny bags and in earthen pots hung from

the roof. None of these are completely satisfactory for preserving jaggery in good conditions particularly during the wet and humid monsoon conditions (Khanna and Chakravarti, 1948).

The results obtained from study conducted at IISR Lucknow (1994) revealed that use of sodium hydro suphite, alum and phosphoric acid for making jaggery increased the reducing sugar from 9.7 to 12.1 per cent and consequently lead to poor storability of jaggery (Banerji *et al.*, 1994).

Moisture studies of jaggery packaged in different packaging material like polyethylene, perforated polyethylene, cellophane paper showed that moisture loss was almost equal in jaggery packaged in perforated polyethylene and unpacked control followed by cellophane paper and polythene without perforation (Anwar *et al.*, 1994).

Ramya *et al.* (2007) assessed the storage quality in commercially available jaggery with different packaging materials and reported that there was an increase in moisture content, reducing sugar and change in colour in jaggery packaged in polyethylene and jute bags. Storage containers of food grade polyethylene proved to be better for storage of jaggery without affecting the quality of jaggery.

In view of facts presented above, proper packaging method needs to be developed to keep the jaggery under good condition for short period of time. Therefore, a research study was conducted to assess the quality of jaggery packaged in different packaging materials and stored under different conditions for a specified period of time with a focus to suggest better packaging and storage methods for farmers.

EXPERIMENTAL METHODS

The different packaging material selected for the study were based on the availability, cost and barrier properties being the basic elements for any materials to retain the product quality. The packaging material used (Fig. A) and treatments imposed are given below:

P_1- Tri layer - aluminum foil (AL) + polyester (PR) + polyethylene (PE) - 800 guage

P_2 - Double layer - polyester (PR) + polyethylene (PE) - 400 guage

P_3 - Single layer - polyethylene (PE) - 400 guage

Packing type:

M_1- Ambient packaging

M_2- Vacuum packaging

The production of jaggery was done in a farmer's jaggery processing plant at Malaiveppankuttai village, Namakkal District, Tamil Nadu and the jaggery was prepared under good hygiene condition by following the scientific principles and methods, keeping in mind some of the basic practices like proper filtration and clarification, removal of scum at different intervals and transferring the syrup at striking point to the molds, maintenance of cleanliness in de-molding area, etc.

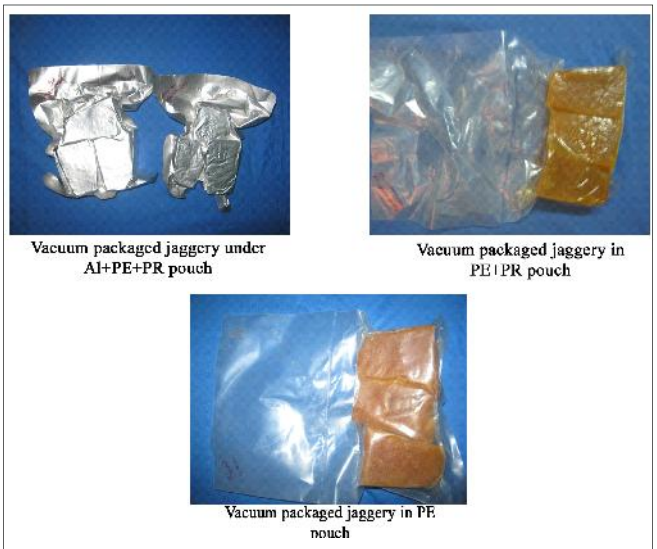

Fig. A : Packaging of jaggery in different packaging materials

After air cooling, jaggery (approx. 300 g) was placed in different packaging material selected and packed under ambient condition and in vacuum condition by heat sealing and vacuum packaging, respectively. The packed jaggery was stored for 10 weeks in dark. The quality analysis was done at weekly intervals. Standard methods were followed to determine the jaggery quality:

Ash content and porosity :

The ash content and porosity of the jaggery was determined using the formula (Asokan and Rupa, 2008):

$$\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{Weight of jaggery}} \times 100$$

$$\text{Porosity (\%)} = \frac{\text{Initial volume of kerosene (cc)} - \text{Final volume of kerosene (cc)}}{\text{Volume of 20 g of jaggery (cc)}} \times 100$$

Moisture content:

Moisture content was estimated gravimetrically by following the procedure outlined by AOAC (Anonymous, 1980).

Hardness:

Hardness (Hardness is a measure of degree of resistance offered by a food material) was tested using a hardness tester (Kiya Seisakusho Ltd. Tokyo, Japan) in which jaggery was kept horizontally under the indenter which moved vertically. When the jaggery started to crack then the reading of the tester was recorded. There were two load indicators namely, the black

one turned due to pressure and went back to zero when the jaggery broke and the red one remained still after breaking the jaggery indicating the breaking load or jaggery hardness. It is expressed as kg force applied.

The change in the colour (ÄE) was observed using a Hunter Lab Colourimeter and the values of L, a, b were used to measure the colour change and the microbial load was analyzed using the plate count method.

The quality parameters like reducing sugar, total reducing sugar and sucrose were determined using the methods followed by Anonymous (2005) and Ranganna (1997).

Net rendement (NR):

Net rendement value is a quality parameter specific to jaggery and is based on the proportion of sucrose, reducing sugar and ash content. Net rendement values were computed according to Indian trade conventions as described by Roy (1951).

Net rendement = [Sucrose (%) – {Reducing sugar (%) + (3.5 x Ash, %)}]

Sensory evaluation:

The organoleptic evaluation of the product (pongal) was done for colour, flavour, texture, taste and overall acceptability (Ranganna, 1997). Nine-point Hedonic scale was used as sensory evaluation score card to bring out the inherent characteristics acceptability of particular product.

EXPERIMENTAL FINDINGS AND ANALYSIS

The jaggery produced (Fig. 1) was subjected to biochemical analysis before storage and after packaging in different packaging materials and following different packaging methods. The samples were taken as per the weekly requirement and stored jaggery quality was analyzed (Table 1).

During storage, different quality parameters like colour, hardness, sucrose, reducing sugar, moisture content, microbial load (bacteria) and porosity of jaggery samples were determined at weekly intervals.

Colour:

The results showed that the colour changed gradually and recorded maximum L value of 48.9 for the jaggery packaged in Al+PE+PR and sealed under vacuum condition and minimum value of 45.8 for the jaggery packaged in PE at ambient packaging. The decrease in the 'L' value indicated the turning of jaggery colour towards black and increase in 'a' value indicated increase in redness. Among the different packaging materials used, the jaggery packaged in Al+PE+PR under vacuum condition recorded minimum change in total colour value (6.69) after ten weeks of storage and jaggery packaged in PE at ambient packaging recorded a maximum change in total colour value (11.75) which was about 2075.92 per cent compared to the initial colour value before storage (Fig. 2).

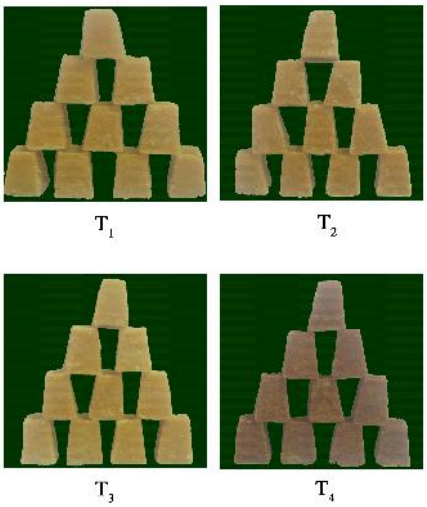

Fig. 1 : Jaggery prepared under different treatments

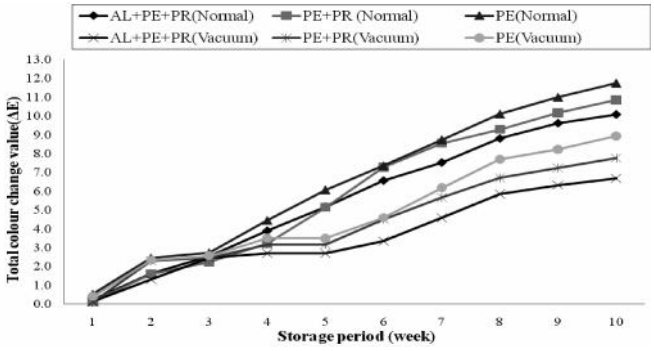

Fig. 2 : Effect of packaging material, packaging conditions and storage duration on total colour of jaggery

Hardness:

During storage, it was observed that the effect of packaging methods on hardness of the jaggery packaged in different packaging materials was distinguishable. After first

Table 1 : Quality parameters of jaggery before packaging

Colour value			Hardness	Sucrose	Reducing	Microbial load	Moisture	Porosity	Ash content	Net rendement
L	a	b	(kg)	(%)	sugar (%)	$\times 10^2$ (cfu/g)	content (%,db)	(%)	(%)	value (Grade)
53.9	9.77	42	19.0	84.3	4.50	4.5	7.53	18.6	4.32	64.78 (A_2)

week of storage the jaggery samples of different treatments recorded gradual decrease in hardness value (Fig. 3). The jaggery packaged in multi-layer film namely Al+PE+PR exibited maximum hardness value during entire period of storage compared to other treatments and recorded a value of 16 kg (15.7 % reduction) and the jaggery packaged in PE at ambient packaging recorded a reduction of 31.5 per cent after 10 weeks of storage.

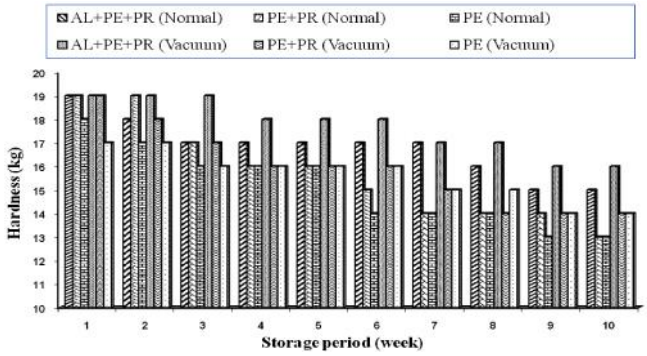

Fig. 3 : Effect of packaging material, packaging conditions and storage duration on jaggery hardness

Microbial load:

The microbial analysis showed that, the presence of microbial load was less in vacuum packaged jaggery compared to ambient packaged, irrespective of packaging material used. The jaggery stored in Al+PE+PR recorded a microbial load of $4.1x10^2$ cfu/g at the end of first week of storage period and $4.4x10^2$ cfu/g at the end of tenth week of storage. Among the different treatments, single layered PE was contaminated with higher microbial load both in ambient air and vacuum packaging conditions (Fig. 4). Singh *et al*. (2009) reported a microbial load value of 1.3 $x10^6$ and 4.8 $x10^6$ cfu/g in commercially available jaggery after fifteen and thirty days of storage under open atmospheric condition. The present study showed the better effectiveness of the use of suitable packaging material and technique for storage of jaggery.

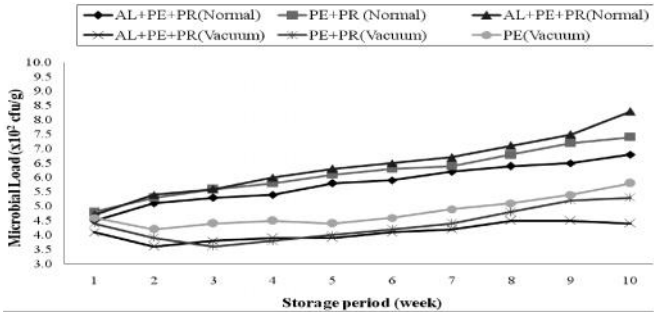

Fig. 4 : Effect of packaging materials, packaging conditions and duration of storage on microbial load of jaggery

Moisture content:

Irrespective of the packaging material used and packaging conditions adopted, the moisture content of jaggery was within 8 per cent (db) only five weeks of storage (Fig. 5). Thereafter, the moisture content started increasing and recorded a maximum value of 11.65 in PE packaged in ambient and a minimum value of 8.55 per cent in Al+PE+PR under vacuum packaging after ten weeks of storage. Benerji *et al.* (1994) reported a similar trend of increase in moisture content of jaggery with increase in storage period.

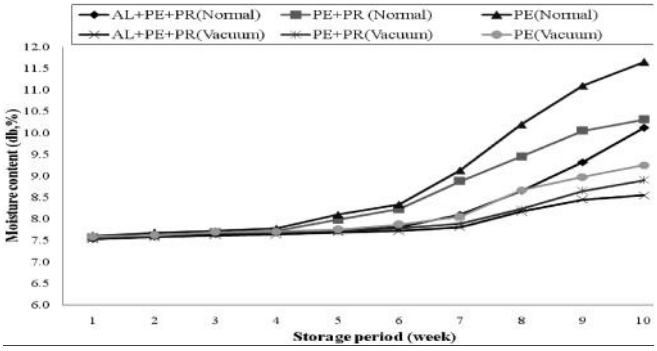

Fig. 5 : Effect of packaging material, packaging conditions and storage duration on the moisture content of jaggery

Reducing sugar:

The reducing sugar content increased in all the treatments, but at different rates based on the micro environment of each treatment (Fig. 6).When compared to all other treatments, jaggery packaged in PE in ambient packaging recorded high reducing sugar and lowest was observed in AL+PR+PE under vacuum condition. Ramya *et al.* (2007) also observed similar results with the increase in reducing sugars from 10.36 per cent to 24.66 per cent in the commercially available samples stored under traditional method for three months, which is in line with the results obtained in the present study.

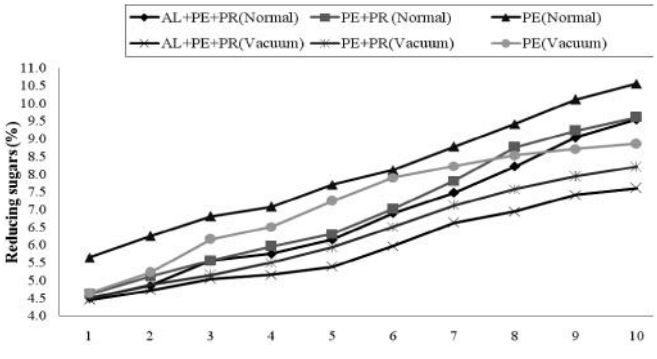

Fig. 6 : Effect of packaging material, packaging conditions and storage duration on the reducing sugar content of jaggery

Sucrose content:

The sucrose content of jaggery stored at ambient and vacuum packaging in PE was 83.4 and 84.0 per cent, respectively, after first week of storage, and decreased gradually and reached a value of 78.06 and 78.65 per cent, respectively, after ten weeks of storage (Fig. 7). In contradiction to the above, the sucrose content was maintained fairly at higher level in the jaggery stored in Al+PE+PR under vacuum condition (84.30 %) after first week and 81.95 per cent after ten weeks of storage period. Khanna and Chacravarthi (1948) has observed the sucrose content loss was more than ten per cent in jaggery stored under open atmospheric condition over a period of one month, that proves the effect of use of AL+PE+PR over reduction in sucrose content during storage.

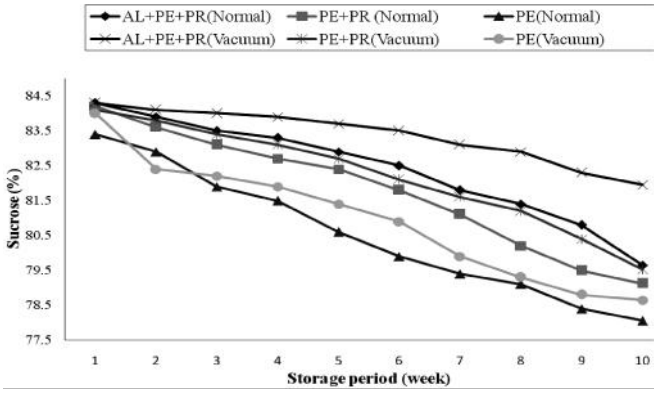

Fig. 7 : Effect of packaging material, packaging conditions and duration of storage on sucrose content of jaggery

Porosity:

The increase in porosity was found to be higher in vacuum packaging compared to ambient packaging irrespective of the packaging material used. The jaggery in PE in ambient packaging recorded minimum increase in porosity throughout the storage period and recorded a porosity of 23.13 per cent (24.3 per cent increase over initial value) at the end of ten weeks of storage (Fig. 8). Also, jaggery packaged in Al+PE+PR under vacuum condition recorded a maximum porosity throughout the storage period. This treatment recorded a porosity value of 34.26 per cent (increase of 84.19 % over initial value) after ten weeks of storage. Khanna and chacravarti (1948) reported about 20 to 30 per cent increase in porosity of jaggery during storage in air tight container.

Ash content:

The triple layer packaging material (Al+PE+PR) under vacuum packaging showed minimum quality deterioration compared to jaggery stored in other packaging materials. The jaggery in triple layered film (Al+PE+PR) under vacuum condition was analyzed and the results revealed an ash content

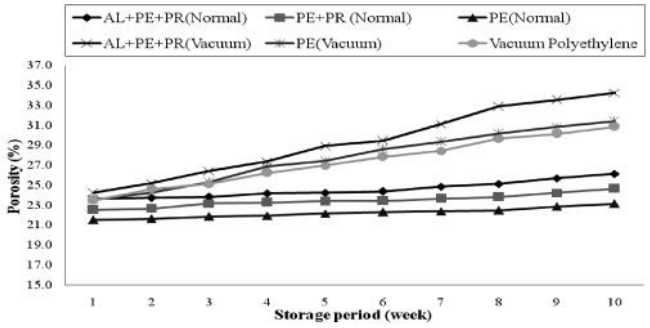

Fig. 8 : Effect of packaging material, packaging conditions and storage duration on porosity of jaggery

of 4.51 per cent (4.3 per cent increase over fresh jaggery) after ten weeks of jaggery storage.

Sensory evaluation:

Sensory evaluation was carried out by preparing "Pongal"- a traditional sweet prepared (Fig. 9) using jaggery, raw rice, ghee, cashew, resins, cardamom and green gram. The mean value of different quality traits of sensory evaluation, namely, colour and appearance, flavour, texture, taste and overall acceptability is presented in Table 2.

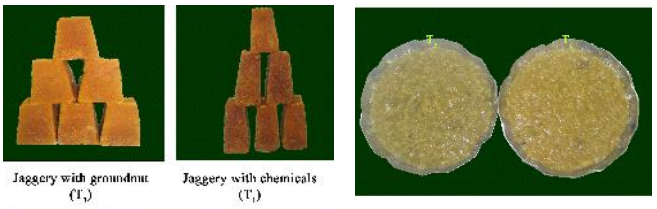

Fig. 9 : Pongal Prepared using different treatments jaggery

Table 2 : Average score values of sensory evaluation of pongal

Parameter	After 10 weeks of storage
Colour	8.21
Flavour	7.40
Texture	7.54
Taste	7.31
Overall acceptability	7.40

Conclusion:

The study clearly revealed that packaging of jaggery produced under a good hygienic condition and packaging in single layer, two layers and triple layers of packaging material and then sealing hermetically (with air) and under vacuum condition (without air) minimised the quality deterioration during the short term storage of ten weeks over the traditional packaging and storage methods. Among the two packaging types, the vacuum packaging restricted changes on different

quality traits of jaggery compared to ambient packaging.

Among the different packaging material evaluated, the triple layer packaging material performed better compared to single and double layer packaging material in minimizing the quality loss of jaggery after packaging and storage.

LITERATURE CITED

Anonymous (1980). *Official methods of analysis*. Association of analytical chemists, 20th Ed., Washington, D.C, USA.

Anonymous (2005). *Manual methods of analysis of foods*. Ministry of Health and Family Welfare, Government of India, New Delhi: 36-49.

Anwar, S.I., Baboo, Bangali and Lal, Nand (1994). Performance evaluation of IISR gur drying cum storage godown. Annual Report of Indian Institute of Sugarcane Research. pp. 103-104.

Asokan, S. and Rupa, T.R. (2008). Sugarcane chemistry including sugar and gur technology. Directorate of Open and Distance Learning, Tamil Nadu Agricultural University, Coimbatore (T.N.) INDIA.

Banerji, R., Madan, V.K., Lal, Nanda and Sewak, Ram (1994). Studies on juice clarification for quality gur. Annual report of Indian Institute of Sugarcane Research: pp. 101-102.

Jadhav, N., Atul and Bhutani, KK. (2005). Ayurveda and gynecological disorders. *J. Ethnopharmacol.*, **97** (1) : 151–159.

Khanna, K.L. and Chakravarti, A.S. (1948). Studies in storage of gur-I. *J. Proceedings: Plant Sci*., **3**(2): 99-119.

Mandal, D., Tudu, S., Mitra, S.R. and De, G.C. (2006). Effect of common packing materials on keeping quality of sugarcane jaggery during monsoon season. *Sugar Technol*., **8** (2&3) : 137-142.

Ramya, H.N., Chowde Gowda, M., Ravindra, Usha and Jayamala, G.B. (2007). Study on packaging and storage materials on quality of jaggery. All India Seminar on Mechanized Cultivation of Sugarcane and Safety- Quality Management in Sugar Industry, Institution of Engineers (India), Bangalore. 329 pp.

Ranganna, S. (1997). *Manual of analysis and quality control for fruit and vegetable products*. Tata McGraw-Hill Publishing Company Limited, New Delhi (INDIA).

Roy, Sailesh Chandra (1951). *Monograph of the gur industry in India*. Indian Institute of Sugarcane Technology. Kanpur. pp. 55-64.

Singh, S., Dubey, Ashutosh, Tiwari, Lakshmi and Verma, A.K. (2009). Microbial profile of stored jaggery: A traditional sweetener. *Sugar Technol*., **11**(2): 213-216.

WEBLIOGRAPHY

http://www.apeda.com/