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PERFORMANCE OF THE JAGGERY STORAGE STRUCTURES ON NORTH INDIA

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Farm level jaggery (Gur) storage methods, commonly used in North India, were evaluated for preserving jaggery. Metallic drum with lids sealed and polyethylene lined gunny bags performed best. The biochemical cgabages were minimum. Any storage system which prevents moisture gain from the surrounding atmosphere preserves the jaggery quality and prevents physico-chemical changes.

Key words: Jaggery, Storage structure, Jaggery storage.

Introduction

Jaggery is a product obtained by concentrating the sugarcane juice, with or without purification, into semi solid/ solid mass in open pans. The shape of jaggery may vary from small round balls to large semi sperical lumps or tappered cylinderical lumps. Nearly half of the sugarcane produced in india is converted into jaggery. In north India, it is prepared between November and March, but since it is marketed and consumed throught the year, a part has to be stored. One third to half of the jaggery produced is stored for consumption during and after the rainy season [1]. Of this quantity, approximately 80% is stored at small scale for domestic consumption. About 50-10% is lost because of its hygroscopic nature, under high humidity conditions and its increase in invert sugar content. This is particularly true during the rainy season.

Roy [2] described the old methods of farm level storage in West and East Uttar Pradesh. Singh [3] described the techniques, currently in vogue into four classes: storage blankets, storage in packing materials, container storage and godown storage. Farm level and domestic storage structures prevalent in North India include: metallic containers, earthen posts, gunny bags in wheat straw, and polyethylene films [4]. Large-scale storage techniques popular in West Uttar Prradesh have been described by Ali [5]; the methods vary with region and agro-climatic conditions. Recent research has resulted in some improvements in these systems as well as in the development of new storage systems including large storages. Kapur and Kanwar [6] evaluated the effect of edible chemicals and packaging materials on the storability of jaggery. However, they did not consider all packaging materials. The storage techniques differ considerably with respect to quality maintenance of the jaggery. In a recent study performance of metal bins, painted earthen post and paper cartons has been evaluated and compared for short term storage of jaggery [7]. Metal bins and painted earthen posts preserved jaggery quality better than paper cartons. Very little published information is available on the new storage techniques. The paper provides an analysis of the available storage methods of jaggery.

Materials and Methods

The performance of several storage methods commonly used in North India has been evaluated under laboratory conditions. The storage methods and their code are given below:

Storage method	Code
Metallic drum (mild steel), lid sealed	SMD
Metallic drum (mild steel), lid looscly placed	UMD
Loose between two 30 cm thick wheat straw straw layers	WS
Gunny bag between two 30 cm thick wheat straw layers	GBWS
Gunny bag	GB
Polyethylene lined bag between two 30 cm thick wheat straw layers	PGBWS
Polyethylene lined bag between two 30 cm thick wheat straw layers	PGBWS
Polyethylene-lined gunny bag	PGB
Earthen pot, sealed with mud mortar	SEP

The studies were conducted with jaggery made from the variety CO 1148 in the first week of April. It is one of the popular varieties in North India suitable for producing good quality jaggery. The initial quality characteristics of the jaggery are as follows:

Moisture content.% (w.b.)	4.05
Colour, % (T)	19.00
Brix, uncorrected	8.50
Brix cirrected	9.00
Pol reading	9.00
Pol, (%)	8.55
Purity, (%)	95.88
Sucrose, (%)	66.38
Reading sugars, (%)	12.44
Total sugars, (%)	78.82

The sample size was 10 kg. The samples were stored in the second week of May. The samples were kept in the open shed for about 5 weeks between the first week of April and second week of May to allow their drying from an initial moisture content of 8% to about 4%. This is a normal practice in North India. The samples stored in gunny bags were used as control. All the samples stored in corresponding storage system/container were placed inside the room equipped with facility to record daily minimum and maximum room temperature and the relative humidity. Each system evaluated had two replications.

Jaggery quality. The physical condition and quality of the stored samples were evaluated before storage and at 8 week intervals until 24 weeks of storage. The quality attributes analysed were: moisture content, colour, brix value, pol percent, purity, sucrose, reducing sugar and total sugars. A brief description of the procedures used for the analysis follows:

Moisture content. The method of Sastry *et. al.* [8] was used, in which 2.5 g of jaggery was dissolved in 2.5 cc of distilled water and the solution was absorbed on a Whatman filter paper of 15 cm dia. The contents were dried at 105• to constant weight. The loss in weight is regarded as a moisture loss; from which the amount of water added was subtracted to obtain the exact moisture loss from the original sample. Subsequently, the moisture loss was translated into the moisture content of the sample. Reported moisture content values are an average of three replications.

Colour. Colour was determined on a 5% solution (5 g of jaggery in 95 g of distilled water) using Photo-Chem colorimeter with 485 nm filter (blue filter). The solution was transferred to the cuvette and the percent transmission was recorded [9].

Brix, pol percentage, purity and sugars. The standard methods recommended by the Sugar Technologists Association of India [9] were employed for determination of brix and pol percentage. The purity was calculated from pol percentage and corrected brix using the equation.

$$\% \text{ purity} = \frac{\text{Pol per cent}}{\text{Brix reading}} \times 100$$

The sucrose, reducing sugars and total sugars were estimated using the methods of Lane and Eynon as reported by Plews [10].

Results and Discussion

The deterioration in physical condition is given in Table 1, which shows that jaggery stored in metallic drums with lid sealed (sample SMD) did not show any significant change in colour, texture and physical appearance till 24 weeks. However, jaggery stored in metallic drums with a losely fitted lid started lossing its texture after the 8th week although the shape remained intact. The fungal growth and a change in texture were observed after 24th week.

Jaggery stored in gunny bag in between two 30 cm layers of wheat straw did not show a deterioration in physical conditions untill the 8th week, after which the texture became soft. From the 16th week onwards fungal growth apeared and samples smelled of fermented molasses. The samples were unfit for human consumption.

TABLE 1. PHYSICAL CONDITION OF JAGGERY AFTER DIFFERENT TIME INTERVALS.

Sample code	Physical condition after 8 weeks	16 weeks	24 weeks
GB*	No change	Lost shape	Completely spoiled
WS	No change	Soft texture	Started liquefying with fungal growth
SMD	No change	No change	No change
UMD	No change	Soft texture	Shape intact, Soft texture, fungal growth appeared
GBWS	No change	Soft texture	Fermentation started
PGBWS	No change	No change	Soft texture
SEP	No change	No change	Appreciable fungal growth

*Control

The control samples were stored in gunny bags and did not suffer physical change untill the 8th week. The samples were completely spoiled after 24 weeks of storage.

The samples stored in polyethylene-lined gunny bags between two 30 cm layers of wheat straw, and those stored without straw were stable until 24 weeks of storage. Some softness in texture was observed starting at the 24th week of storage. The softness was within acceptable limits.

The samples stored in earthen pots remained unaffected until the 16th week. Subsequently, fungal growth was seen. The texture remained unchanged.

Jaggery samples, loosely stored between two 30 cm layers of straw were unstable and showed changes in physical condition after the 8th week. A profound change in physical attributes was observed after 24 weeks of storage. The samples lost marketability due to their sticky nature and mouldy appearance. Insect infestation was also noted after 24 weeks. The changes are attributed to moisture absorption and the resulting biochemical degradation of the sugar constituents.

The results of the quality analysis after different storage periods (8 weeks, 16 weeks and 24 weeks) under different conditions of storage are presented in Table 2. The deviation in quality from the initial quality are noted in Table 3. The brief discussion of the biochemical changes follows.

The moisture content increased in all the stored jaggery samples. The increase ranged from a minimum of 3.95% for the polyethylene-lined gunny bag to a maximum of 9.25% for the samples stored in the wheat straw.

TABLE 2. RESULTS OF JAGGERY QUALITY ANALYSIS+

Storage period	Sample code	Moisture content (%)	Colour (%) T	Corrected brix	Pol (%)	Purity (%)	Sucrose (%)	Reducing sugar sugar (%)
8	GB	5.6	18.0	9.65	8.67	90.16	83.77	10.66
	WS	6.2	14.0	8.82	7.54	85.49	60.01	13.33
	SMD	3.6	23.0	9.49	8.43	88.81	73.52	14.26
	UMD	4.9	23.5	9.36	8.79	93.92	69.64	10.59
	GBWS	3.8	18.5	9.74	9.18	94.71	75.03	9.78
	PGBWS	4.6	22.0	9.69	8.52	87.92	65.40	11.15
	PGB	4.1	12.5	8.96	8.79	98.10	65.12	9.65
	SEP	5.3	21.0	9.45	8.18	87.12	66.16	12.45
16	GB	12.1	21.0	8.61	4.28	49.76	57.78	17.65
	WS	11.8	27.5	8.96	5.93	66.14	65.02	9.09
	SMD	7.4	42.0	9.26	6.04	65.04	71.70	10.80
	UMD	8.1	39.5	9.21	6.48	70.52	68.67	11.21
	GBWS	9.5	42.0	9.26	6.23	67.48	70.36	13.80
	PGBWS	7.2	33.5	9.36	6.92	73.89	57.17	16.19
	PGB	6.9	45.5	9.06	7.05	77.81	64.98	10.30
	SEP	9.9	48.7	9.06	6.05	66.77	63.14	14.36
24	GB	Spoiled	–	–	–	–	–	–
	WS	13.3	49.0	8.65	4.66	53.83	67.55	6.66
	SMD	8.8	62.0	8.80	4.78	54.32	74.49	12.94
	UMD	9.9	51.0	8.65	4.60	53.17	69.66	11.37
	GBWS	11.6	58.7	8.35	4.79	57.71	67.40	12.84
	PGBWS	8.4	46.0	8.65	5.03	58.15	62.01	11.91
	PGB	8.0	60.0	8.85	5.83	65.84	68.08	6.51
	SEP	11.6	67.0	8.55	5.11	61.14	68.01	10.94

+ Results reported are the average of two replications

TABLE 3. DEVIATIONS IN JAGGERY QUALITY PARAMETERS AFTER 24 WEEKS OF STORAGE.

Quality attribute	Condition	Sample code							
		GB	WS	SMD	UMD	GBWS	PGBWS	PGB	SEP
Moisture,%	Initial	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05
	after storage	–	13.30	8.80	9.90	11.60	8.40	8.00	11.60
	deviation	–	+9.25	+4.75	+5.85	+7.55	+4.35	+3.95	+7.55
Colour,%T	Initial	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
	after storage	–	49.00	62.00	51.00	58.70	46.00	60.00	67.00
	deviation	–	+30.00	+43.00	+32.00	+39.70	+27.00	+41.00	+48.00
Corrected	Initial	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Brix	after storage	–	8.65	8.80	8.65	8.35	8.65	8.85	8.55
	deviation	–	-0.35	-0.20	-0.35	-0.65	-0.35	-0.15	-0.45
Pol, %	Initial	8.50	8.55	8.55	8.55	8.55	8.55	8.55	8.55
	after storage	–	4.66	4.78	4.60	4.79	5.03	5.83	5.11
	deviation	–	-3.89	-3.77	-3.95	-3.76	-3.52	-2.72	-3.44
Purity, %	Initial	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00
	after storage	–	53.83	54.32	53.17	57.71	58.15	65.84	61.14
	deviation	–	-41.17	-40.68	-41.83	-37.29	-36.85	-29.16	-33.86
Sucrose,%	Initial	66.38	66.38	66.38	66.38	66.38	66.38	66.38	66.38
	after storage	–	67.55	74.49	69.66	67.40	62.01	68.08	68.01
	deviation	–	+1.77	+8.11	+3.28	+1.02	-4.37	+1.70	+1.63
Reducing	Initial	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44
sugars, %	after storage	–	6.66	12.94	11.37	12.84	11.91	6.51	10.94
	deviation	–	-5.78	+0.50	-1.07	+0.40	-0.53	-5.93	-1.50

The initial brix content of the samples stored was 9.0. The values of the brix after storage ranged from 3.35 to 8.85. The minimum decrease in brix occurred in the samples stored in the polyethylenelined gunny bags (0.15), and in those stored in the sealed metallic drums (0.20). The maximum decrease (0.65) happened in the gunny bag samples stored in wheat straw.

The pol percentage, which was 8.35 initially, decreased by 2.72% to 3.95% after storage. The minimum decrease (2.72%) was recorded for samples stored in the polyethylene-lined gunny bags while the maximum (3.95% occurred in the unsealed metallic drums.

Purity of the stored samples decreased in all the cases from an initial value of 95% to somewhere in the range between 53.17 and 65.84%. The decrease was maximum (41.83%) for unsealed drums and minimum (29.16%) for the polyethylene-lined gunny bags.

The sucrose content, in general, increased. The initial value was 66.38%. Only one sample (polyethylenelined gunny bags stored in wheat straw) showed a decrease in sucrose level. The maximum increase of 8.11% occurred in the sealed metallic drum while the lowest increase (1.02) was noticed in the gunny bags containing the straw layers.

The level of the reducing sugars showed an incease in some samples and a decrease other. An increase was oberved for the sealed metallic drums and the polyethylene-lined gunny bags with wheat straw. The remaining samples showed a decrease in the level of reducing sugar.

Conclusions

The results presented in Tables 2 and 3 clearly show that the samples stored in the polyethylene-lined gunny bags and sealed in metallic drums suffered a minimum of biochemical changes. Kapur and Kanwar [6] also found the maximum deterioration in the gunny bags and minimum in the tin box i.e. metallic containers. They also observed that making the storage structure air tight reduced rate of deterioration. T all storage systems which prevent moisture gain can b effectively utilized for the storage of jaggery.

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