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Assessment of quality attributes and storage behavior of jam prepared from different mango varieties grown at Malda district

B Krishna, AK Banik and S DasDOI: <https://doi.org/10.22271/chemi.2020.v8.i2g.8807>**Abstract**

In the present investigation to determine the suitability of mango varieties for Jam preparation, five Malda grown mango varieties namely, Himsagar, Lakshmanbhog, Amrapali, Fazli and Kishanbhog were utilized along with assessment of storage behavior of the end product. During the period of study TSS, ascorbic acid, titratable acidity, total sugars, reducing sugars, non reducing sugars, pH, microbial count in processed product and Organoleptic evaluation were assessed from initial day of storage to 180th day of storage. With the advancement in the length of storage interval TSS, reducing sugar and total sugar content and titratable acidity showed a gradual increase upto 180 days of storage. The overall assessment of quality revealed that with respect to conjugal study of all these parameters jam prepared from the variety Himsagar proved considerably superior. The maximum Overall acceptability score (7.79) also had been gathered by jam manufactured from Himsagar variety.

Keywords: Jam, malda, mango, organoleptic, overall acceptability, storage**Introduction**

Mango (*Mangifera indica* L.) is the most important commercial fruit in India. In India presently mango occupies 2.125 million hectares area with an annual production of 19.004 million ton (Anon, 2017) ^[1]. India produces about 56% of the total mango in the world. Post harvest losses of fruits and vegetables in our country are very high i.e. 20 to 30% every year (Saigal, 2001) ^[22]. However only 2% of the total production is used for processing, where as this figure is more than 50% in developed countries (Roy, 2001) ^[20]. Mangoes are classified as climacteric fruit and ripen quite rapidly after harvest. Disease problems, sensitivity to low temperature storage and the severe perishable nature of the fruit limit the transport of fresh fruit from the site of harvest to distance places (Lizada, 1993) ^[13]. These losses can be minimized by utilizing green fruits for making pickle or chutney or as a sundried acidifying condiment (AMCHUR), where as ripe fruit is used for preserve, jam, squash etc. (Srivastava, 1998) ^[25]. Processing of mango fruits into juice, jam or dried products ensures its consumption throughout year besides recovery of bio-constituents such as vitamin A (Doreyappa and Ramanjaneya, 1995) ^[4]. The physico-chemical characteristics of mango fruits and the technological qualities of their processed products vary with mango varieties as some are more suitable than others for specific applications (Mercadante and Rodriguez, 1998) ^[15]. Mango fruit processing into jam provide added value to fruit. Jam is usually prepared from cooked fruit or vegetable, sugars citric acid and pectin (Broomfield, 1996) ^[2]. Ripe mango varieties are the best suited for Jam processing based on their viscosity (Kansci *et al.*, 2003) ^[10]. Realizing the importance of mango fruits, nutrition, perishable nature, seasonal availability and no indigenous research work on suitability of mango varieties for jam production along with the storability study of the processed products, the present investigation was carried out to assess the varietal suitability of mango for jam preparation and to identify the storage stability of mango jam at ambient temperature.

Materials and methods

In the present research work ripe mangoes were collected from ten blocks of Malda Sadar and Chanchal sub-division of Malda district, West Bengal, India

(situated at 25 M above mean sea level ;the latitude and longitude being 240 40'20"N to 250 32'08"N and 870 45'50"E to 880 28'10"E, respectively and jam was prepared at the Department of Post Harvest Technology of Horticultural Crops, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia during the period from 2016-17 and 2017-18. The collection centre of mango fruits is situated in the Lower Gangetic Plain Agro Climatic Zone of West Bengal. The soil of the location was clay to loam and it was sufficiently deep. The pH of the soil was slightly acidic to neutral and varied from 6.0 to 6.8.

Preparation of mango jam

Total Number of varieties: (Treatments):	5(Himsagar, Lakshmanbhog, Amrapali, Fazli and Kishanbhog)
Stage of fruit:	Optimum maturity stage
Storage condition:	Ambient temperature
Packaging:	Glass jars (200ml)

Methodology

The mango fruits of Kishanbhog, Laxmanbhog, Himsagar, Fazli, and Amrapali varieties were collected from the mango orchard, Mango Research Station, Malda, West Bengal, India. Fruits are fully ripe, sound mangoes, and free from injured and deteriorated parts were selected for making the jam. The selection of the mango varieties depended on the most important characteristics which needed for jam production (high weight, high pulp content, low stone and peel content and low in fiber).

Preparation of mango pulp for jam making

The T.S.S. of the pulp was measured by hand refractometer then Pearson square was used to calculate the amount of sugar to be added.

Processing

The prepared pulp is placed in cooking kettle. The addition of ingredients during cooking process is divided into two steps:

1st - The addition of half of the amount of sugar, then addition of suitable amount of citric acid which was calculated by trial batch (to adjust the pH) during the boiling process, then stirred well until 50° Brix of solids was reached.

2nd - The remaining quantity of sugar was added. stirred well until 64° Brix of solids reached, then add the required amount of pectin, stirred well until the solids reached 67-68° Brix, before which sodium benzoate was added at the rate of (2.5g/kg), then previously sterilized jars were filled while the mixture was hot and then quickly sealed hermetically and cooled by water spray. Jars cooling, washing and labeling are the last stages before storage.

Recipe for mango jam

S. No.	Ingredients	Quantity
1	Pulp	1 kg
2	Sugar	0.75 kg
3	Citric acid :	2 g
4	Water	100 ml
5	Pectin	1%

Observations recorded

During the period of study, observation on TSS%, Ascorbic acid (mg 100 g⁻¹), Acidity (%), Total sugars (%), Reducing sugars (%), Non reducing sugars (%), P^H Microbial count in processed product and Organoleptic evaluation were assessed at initial day of storage, 30th, 60th, 90th, 120th, 150th and 180th

day of storage. The details procedure of assessment was mentioned under physico-chemical analysis.

Statistical Analysis

For analysing the influence of varietal differences and storage intervals on the quality of value added mango (*Mangifera indica* L.) products of Malda district, the experiment was laid out in two factors Completely Randomized Design (CRD) with three replications. The varietal effects were taken as the first factor and the influence of storage intervals were considered as the second factor during the statistical analysis. The data relating to quality attributes of the processed mango products recorded during the period of experimentation were statistically analyzed by following analysis of variation method using MSTAT software. For inference 5% level of significance of 'F' and 't' test were applied.

Results and discussion

The influence of duration of storage on the quality of jam prepared from various mango varieties had been described on the light of TSS content, acidity percentage, pH level, reducing and total sugar content, overall acceptability score and microbial load.

Influence on TSS content

Jam prepared from different mango varieties i.e. Himsagar, Lakshmanbhog, Amrapali, Fazli and Kishanbhog could not reveal any statistical difference under the sole influence of varieties with respect to TSS content (Table 1). On the other hand, storage intervals showed prominent variation over the TSS content of jam. The value of TSS increased from 68.42°Brix to 71.51°Brix from initial value to 180 days of storage period. The continuous increase in TSS content of Jam during storage, irrespective of varieties, might be due acid hydrolysis of polysaccharides especially gums and pectin (Luh and Woodroof, 1975). The interaction of effect of mango cultivars and storage interval viz., initial, 30, 60, 90, 120, 150 and 180 days after storage (DAS) also unable to create any remarkable variation on the TSS content of jam. Data, regarding TSS content, indicated that the values of this parameter in all jams were higher than in fresh fruits pulp, and it might be attributed mainly to the of addition of sugar as well as thermal process that reduced water content (Khan, 1989)^[11].

Influence on acidity percentage

Under the sole influence of varieties the acidity level of jam produced considerable variation (Table 2). The considerable variation of acidity level of jam prepared from different mango varieties also has been reported by Safdar *et al.* (2012)^[21]. The highest acidity percentage (0.53%) was documented from jam produced from the variety Lakshmanbhog, whereas the lowest acidity level (0.47%) was measured for jam made from Amrapali. Storage durations viz., initial, 30, 60, 90, 120, 150 and 180 DAS showed the acidity levels of jam as 0.46%, 0.47%, 0.48%, 0.50%, 0.51%, 0.53% and 0.54%, respectively. The significant and gradual increase in acidity level of jam upto 4 months of storage also had been reported by Nour *et al.* (2011)^[18]. The increase in acidity might be due to the formation of acids by degeneration of polysaccharides and oxidation of reducing sugars by break down of pectic substances and uronic acid (Iqbal *et al.*, 2001 and Hussain *et al.*, 2005)^[7]. As far as the interaction of variety and storage interval is concerned, the conjugal effect of both these factors could not create statistical variation over acidity level of jam.

The maximum acidity of 0.57%, in mathematical term, was observed in Jam prepared from variety Lakshmanbhog at 180 DAS.

Influence on pH

Varietal differences in jam making showed remarkable variation in pH level of this product (Table 3). The highest and lowest pH of jam had been shown as 3.60 and 3.46 with the use of Amrapali and Lakshmanbhog varieties during jam preparation, respectively. The sole influence of storage duration proved it's effectiveness to bring about statistical variation over pH level of jam. The highest pH levels at 0 DAS had been registered as 3.61, which subsequently increased to 3.46 at 180 DAS. Change in pH is directly related to change in acidity of the samples. So, as the acidity of jam increased with longer storage duration, the pH level also decreased subsequently. Decrease in pH as a consequence to increase in titrable acidity of jam also had been advocated by Kalra and Tondon (1985) [8]. Chauhan *et al.* (2008) [3] also reported that, acidity of guava jam was increased slightly during storage. Harsimrat and Dhawan (1998) [5] also supported in view. The pH of jam failed to exhibit any considerable variation under the influence of interaction of variety and storage duration.

Influence on reducing sugar content

The highest reducing sugar content (36.77%) had been measured in mango jam prepared from variety Himsagar, which differed significantly from jam prepared from all other varieties except that of Fazli (Table 4). The level of reducing sugar showed a positive relationship with storage duration, as it increased with longer storage duration. At the initial stage reducing sugar was observed as 30.49%, which increased subsequently upto 180 DAS with value of 36.95%. The slight increase in reducing sugar content of jam prepared from mango varieties Magloba and GulbAltour during storage also had been reported by Nour *et al.* (2011) [18]. Kannan and Thirumaran (2001) [9] also observed a gradual increase (30.10 to 36.50%) of reducing sugar from jamun jam stored in colourless bottles during storage of six months at room temperature. The combined influence of variety and storage interval could not exert any considerable variation for reducing content of jam.

Influence on total sugar content

Among the mango varieties under present study Himsagar was the best one to have 50.04% total sugar in mango jam (Table 5). Solitary influence of storage duration was strong enough to produce statistical variation for total sugar content of jam. The highest total sugar content was registered at 0 DAS (58.34%) and it reduced to the lowest (39.61%) at 180 DAS. Keeping similarity to the present result, Saravanan *et al.* (2004) [23] observed that total sugar were decreased significantly in papaya jam throughout the storage period. There was a decreasing trend, in case of total sugars, with the increasing storage period in ber jam also had been advocated by Prasad and Mali (2006) [19]. Like that of reducing sugar content, the total sugar content also failed to show any remarkable variation under the conjugal influence of variety and storage period.

Influence on overall acceptability

Overall acceptability score of mango jam was estimated with the integral assessment of taste, colour, flavour and texture. In this aspect varietal difference could evolve significant variation for jam (Table 6). Himsagar was come out as the best variety for jam preparation from overall acceptability point of view with a score of 7.79. As supportive evidence to this result the significant influence of cultivars over acceptability of mango jam also had been stated by Nour *et al.* (2011) [18] and Safdar *et al.* (2012) [21] in their experimental findings. With the increase in storage duration a significantly declining trend for overall acceptability of jam had been visualized. The decline in organoleptic quality of bael jam during storage period also had been reported by Mishra and Chopra (2006) [16] and they also found the best quality of this product immediately after preparation. Singh (2005) [24] opined that the factors responsible for the fast decrease of overall acceptability were mainly deterioration of colour, taste and flavour, which lead to the poor score value on 105 days of storage for apple products. The effect of combination of variety and storage was insignificant with respect to create variation upon the overall acceptability score of jam.

Influence on microbial load

To evaluate the microbial interference during storage for jam prepared from various mango varieties in the present study three types of colony forming units for both bacterial and fungal population detection had been examined. For detecting bacterial growth in the product 10^{-4} , 10^{-5} and 10^{-6} levels of colony forming units were counted (Table 7). Among the varieties Fazli and Kishanbhog resulted in comparatively much higher colony in this regard after 180 DAS, which were 15.00×10^{-4} , 11.00×10^{-5} and 5.00×10^{-6} and 19.00×10^{-4} , 12.00×10^{-5} and 9.00×10^{-6} , respectively. On the other hand, the least numbers of colony i.e. 5.00×10^{-4} , 4.00×10^{-5} and 2.00×10^{-6} were developed in jam prepared from Himsagar variety of mango during the same interval period. With respect to the development of fungal population the type colony forming units were studied as 10^{-2} , 10^{-3} and 10^{-4} during the entire storage period (Table 8). The notable fact in this aspect is that there were a very negligible growth of fungal unit had been visualized upto 120 DAS, but from there after the fungal population showed a rapid growth rate. The added sugar in jam exerted an osmophilic loads in jam. This consequently prevented the rapid microbial spoilage (Nicol, 1980) [17]. Results were in agreement with the earlier investigations of Nour *et al.* (2011) [18]. Comparatively lower growth of fungal population as 2.00×10^{-2} , 1.00×10^{-3} and 1.00×10^{-4} and 4.00×10^{-2} , 3.00×10^{-3} and 2.00×10^{-4} were documented in the jam prepared from Himsagar were detected at 150 DAS and 180 DAS, respectively. These values were observed as much higher in Fazli jam during the same time frame. The lesser growth of bacterial as well as fungal population during storage of jam made from Himsagar variety might have exerted considerable influence over retention of taste, colour, flavour and texture of it in long run. This in turn helped in to fetch higher overall acceptability score for Himsagar mango jam.

Table 1: TSS (⁰Brix) content of jam as influenced under the sole and interaction effects of variety of mango (*Mangifera indica* L.) and storage duration

Cultivars (V)	Storage interval days (D)							Mean
	0	30	60	90	120	150	180	
Fazli	68.69	69.13	69.59	69.93	70.42	70.81	71.06	69.95
Lakshmanbhog	68.03	68.48	68.79	69.19	69.67	70.06	70.47	69.24
Amrapali	68.42	69.69	70.03	70.44	70.71	71.07	71.51	70.27
Himsagar	68.61	69.04	69.27	69.71	70.06	70.87	70.91	69.78
Kishanbhog	69.51	69.93	69.35	69.88	70.15	71.32	71.56	70.24
Mean	68.65	67.25	67.41	67.83	68.20	68.83	71.10	

Particulars	Variety (V)	Storage duration (D)	Variety X Storage duration (V X D)
S.Em. (±)	0.384	0.454	1.016
C.D. at 5% level	N.S.	1.284	N.S.

Table 2: Titratable acidity (%) of jam as influenced under the sole and interaction effects of variety of mango (*Mangifera indica* L.) and storage duration

Cultivars (V)	Storage interval days (D)							Mean
	0	30	60	90	120	150	180	
Fazli	0.47	0.47	0.48	0.49	0.51	0.53	0.54	0.50
Lakshmanbhog	0.49	0.50	0.51	0.53	0.54	0.55	0.57	0.53
Amrapali	0.42	0.44	0.46	0.47	0.49	0.50	0.51	0.47
Himsagar	0.46	0.48	0.49	0.50	0.51	0.55	0.56	0.51
Kishanbhog	0.44	0.45	0.47	0.49	0.51	0.52	0.53	0.49
Mean	0.46	0.47	0.48	0.50	0.51	0.53	0.54	

Particulars	Variety (V)	Storage duration (D)	Variety X Storage duration (V X D)
S.Em. (±)	0.008	0.010	0.021
C.D. at 5% level	0.023	0.027	N.S.

Table 3: pH of jam as influenced under the sole and interaction effects of variety of mango (*Mangifera indica* L.) and storage duration

Cultivars (V)	Storage interval days (D)							Mean
	0	30	60	90	120	150	180	
Fazli	3.61	3.60	3.60	3.57	3.55	3.53	3.47	3.56
Lakshmanbhog	3.56	3.52	3.49	3.44	3.42	3.41	3.39	3.46
Amrapali	3.67	3.66	3.62	3.60	3.59	3.56	3.53	3.60
Himsagar	3.59	3.57	3.54	3.47	3.46	3.43	3.41	3.50
Kishanbhog	3.64	3.63	3.61	3.58	3.57	3.56	3.51	3.59
Mean	3.61	3.60	3.57	3.54	3.52	3.50	3.46	

Particulars	Variety (V)	Storage duration (D)	Variety X Storage duration (V X D)
S.Em. (±)	0.011	0.013	0.030
C.D. at 5% level	0.032	0.037	N.S.

Table 4: Reducing sugar (%) content of jam as influenced under the sole and interaction effects of variety of mango (*Mangifera indica* L.) and storage duration

Cultivars (V)	Storage interval days (D)							Mean
	0	30	60	90	120	150	180	
Fazli	33.18	34.28	35.05	36.21	37.37	38.45	39.63	36.31
Lakshmanbhog	27.25	28.46	29.59	30.72	31.83	32.89	33.96	30.67
Amrapali	28.12	29.25	30.31	31.47	32.52	33.65	34.71	31.43
Himsagar	33.89	34.96	35.44	36.65	37.71	38.82	39.91	36.77
Kishanbhog	30.02	31.15	32.23	33.29	34.35	35.41	36.52	33.28
Mean	30.49	31.62	32.52	33.67	34.76	35.84	36.95	

Particulars	Variety (V)	Storage duration (D)	Variety X Storage duration (V X D)
S.Em. (±)	0.684	0.810	1.810
C.D. at 5% level	1.934	2.288	N.S.

Table 5: Total sugar (%) content of jam as influenced under the sole and interaction effects of variety of mango (*Mangifera indica* L.) and storage duration

Cultivars (V)	Storage interval days (D)							Mean
	0	30	60	90	120	150	180	
Fazli	56.96	53.81	50.73	47.56	43.38	40.25	39.09	47.40
Lakshmanbhog	57.55	54.43	51.28	48.08	44.93	41.81	38.65	48.10
Amrapali	59.02	56.86	52.71	48.43	45.27	42.14	40.00	49.20
Himsagar	59.80	57.59	53.45	49.32	46.17	43.06	40.91	50.04
Kishan bhog	58.36	55.19	52.52	48.27	45.05	42.01	39.39	48.68

Mean	58.34	55.58	52.14	48.33	44.96	41.85	39.61	
Particulars	Variety (V)	Storage duration (D)			Variety X Storage duration (V X D)			
S.Em. ($\pm$)	0.390	0.461			1.031			
C.D. at 5% level	1.101	1.303			N.S.			

Table 6: Overall acceptability score of jam as influenced under the sole and interaction effects of variety of mango (*Mangifera indica* L.) and storage duration

Cultivars (V)	Storage interval days (D)							Mean
	0	30	60	90	120	150	180	
Fazli	7.69	7.63	7.59	7.56	7.51	7.48	7.46	7.56
Lakshmanbhog	7.63	7.57	7.54	7.50	7.47	7.44	7.40	7.51
Amrapali	7.82	7.76	7.73	7.69	7.66	7.64	7.61	7.70
Himsagar	7.90	7.86	7.82	7.79	7.74	7.71	7.68	7.79
Kishanbhog	7.88	7.81	7.77	7.74	7.68	7.65	7.62	7.72
Mean	7.78	7.73	7.69	7.64	7.61	7.58	7.55	
Particulars	Variety (V)	Storage duration (D)			Variety X Storage duration (V X D)			
S.Em. ($\pm$)	0.030	0.036			0.080			
C.D. at 5% level	0.085	0.101			N.S.			

Table 7: Bacterial population (cfu/g) as detected in jam under the sole influence and interaction effects of variety of mango (*Mangifera indica* L.) and storage duration

Cultivars (V)	Storage interval days (D)																				
	Initial			30			60			90			120			150			180		
	Type of C.F.U.			Type of C.F.U.			Type of C.F.U.			Type of C.F.U.			Type of C.F.U.			Type of C.F.U.			Type of C.F.U.		
	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶
Fazli	ND	ND	ND	1.00	ND	ND	3.00	2.00	1.00	4.00	3.00	1.00	6.00	3.00	2.00	12.00	7.00	5.00	15.00	11.00	5.00
Lakshmanbhog	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.00	ND	ND	2.00	1.00	ND	5.00	3.00	3.00	7.00	5.00	4.00
Amrapali	ND	ND	ND	ND	ND	ND	ND	ND	2.00	5.00	2.00	ND	5.00	3.00	1.00	9.00	5.00	4.00	12.00	7.00	6.00
Himsagar	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.00	1.00	ND	3.00	1.00	1.00	5.00	4.00	2.00
Kishanbhog	ND	ND	ND	ND	ND	ND	2.00	ND	ND	7.00	3.00	2.00	9.00	5.00	4.00	14.00	7.00	7.00	19.00	12.00	9.00

ND – Not Detected, C.F.U. – Colony Forming Unit

Table 8: Fungal population (cfu/g) as detected in jam under the sole influence and interaction effects of variety of mango (*Mangifera indica* L.) and storage duration

Cultivars (V)	Storage interval days (D)																				
	Initial			30			60			90			120			150			180		
	Type of C.F.U.			Type of C.F.U.			Type of C.F.U.			Type of C.F.U.			Type of C.F.U.			Type of C.F.U.			Type of C.F.U.		
	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻²	10 ⁻³	10 ⁻⁴
Fazli	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.00	3.00	4.00	9.00	7.00	6.00
Lakshmanbhog	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.00	2.00	1.00	5.00	4.00	4.00
Amrapali	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.00	3.00	2.00	7.00	5.00	4.00
Himsagar	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.00	1.00	1.00	4.00	3.00	2.00
Kishanbhog	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.00	ND	ND	1.00	2.00	ND	2.00	1.00	1.00	3.00	3.00	2.00

ND – Not Detected, C.F.U. – Colony Forming Unit

Conclusion

The overall assessment of quality revealed that with respect conjugal to study of all these parameters the variety Himsagar had a definite positive impact over the end product. The maximum Overall acceptability score had been gathered by jam manufactured from Himsagar variety. From the point of view of advancement in the length of storage interval TSS, reducing sugar and total sugar content and acidity percentage showed a gradual increase upto 180 days of storage.

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