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Studies on Keeping Quality of Preserved Guava Pulp during Storage

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This study was carried out to evaluate the best preservation methods and suitable variety for guava pulp preservation. For this the pulp of two guava varieties (L-49 and Lalit) were preserved with nine different treatments *viz.*, potassium meta bi-sulphite 0.1% (T_1), sodium benzoate 0.1% (T_2), potassium meta bi-sulphite + sodium benzoate 0.05% each, sodium benzoate + potassium sorbate 0.05% (T_4), potassium meta bi-sulphite + potassium sorbate 0.05% each (T_5), potassium sorbate 0.025% (T_6), potassium sorbate 0.05% (T_7), potassium sorbate 0.1% (T_8) and frozen storage -20^0 C (T_9), replicated four times under factorial complete randomized design. The results revealed that low temperature (-20 ^{0}C) storage was better with over all qualitative attributes viz., TSS, sugars, ascorbic acid, pH and L colour value higher and acidity, NEB and microbial count lower. Further, at ambient storage condition potassium meta bi-sulphite 0.1% and potassium sorbate 0.1% were effective in storage of guava pulp. Compared to Lalit and L-49 guava varieties pulp storage, Lalit possess low non enzymatic browning (NEB), L- colour value and microbial count during the entire storage period (up to 90 days).

Introduction

Guava (*Psidium guajava* L.) is one of the most exquisite, nutritionally valuable and remunerative fruit of the tropics and belongs to the family "Myrtaceae". Guava is also called the "Apple of Tropics" and "Poor man's apple". Guava is quite hardy, prolific bearer and highly remunerative even without much care. It is widely grown all over the tropics and sub-tropics including India. Fruit consist of 20 per cent peel, 50 per cent flesh and remaining portion as seed core (Wilson, 1980). Guava fruit normally consumed as fresh as a dessert fruit due to excellent flavour, high digestive and nutritive value, high palatability and availability in abundance of guava fruits show great potential for processing into valuable products, which have nutritional as well as health benefits. It's a better option for further use to make number of processed products such as nectar, squash, clarified juice, concentrates, canned, dehydrated powder, jam, RTS, cheese and blends with other juices. Surplus produce use in processing of fruit into various products is one of the best ways to reduce post harvest losses (Bons *et al.*, 2013).

Guava tree bears two crops during rainy and winter season in sub tropics. Guava tree has tendency to bear maximum crop during rainy

season. This crop is poor in quality and the fruit are rough, insipid, watery and less nutritive. Rainy season fruits are also spoiled rapidly due to loss of glossy appearance with discoloration followed by blemishes, desiccation, loss of firmness and vitamin C after harvest. Rainy season fruits owing to high perishability, less storability (not more that 3 days) and poor taste restrict its consumption as a fresh fruit in this season and farmers' could not get reasonable price of their produce. The post harvest losses occurs about 22 per cent (Bons and Dhawan, 2006). Therefore, need of the hour to use this rainy season crop through stored in form of pulp to increase its availability over an extended period and to stabilize the price during glut season and can be further utilize for preparation of various value added products. Keeping this in view the present experiment was conducted.

Materials and Methods

The experiment was carried out in the Fruit and Vegetable processing lab, Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur (Raj.) during the year July, 2015 to November, 2015. Fully mature and ripe guava cv. Lalit and L-49 fruits were procured from horticulture farm. The pulp was extracted by hot method (90^0C). Obtained pulp was preserved with nine different treatments namely, potassium meta bi-sulphite 0.1% (T_1), sodium benzoate 0.1% (T_2), potassium meta bi-sulphite + sodium benzoate 0.05% each, sodium benzoate + potassium sorbate 0.05% (T_4), potassium meta bi-sulphite + potassium sorbate 0.05% each (T_5), potassium sorbate 0.025% (T_6), potassium sorbate 0.05% (T_7), potassium sorbate 0.1% (T_8) and frozen storage -20^0 C (T_9) and replicated four times with two units. Physico-chemicals parameters of samples were observed at 0, 30, 60, 90 days of storage. The TSS content of pulp was directly measured by the "Digital Refractometer" (Brix: 0.0 to 53.0 %) at 20^0C temperature. Ascorbic acid by 2,6-dichlorophenol – indophenols dye method and acidity content of pulp was determined by diluting the known volume of pulp with distilled water and titrating the same against standard N/10 sodium hydroxide solution, using phenolphthalein as an indicator (A.O.A.C., 1995). Reducing sugars was measured by following "DNS Method" (Miller, 1959). Total Sugar was estimated by using "Anthrone Method" (Dubois *et al.*, 1951). The pH of the pulp was directly measured on the pH meter. The non-enzymatic browning (NEB) in the pulp was determined by measuring optical density (OD) of methanol extracts of samples at 440 nm in UV-VIS spectrophotometer (Labomed Inc., USA). Numbers of bacteria were counted by using Thornton's medium and fungi were counted by using martin's Rose-Bengal medium. The data were analysed by using Factorial completely randomized design (Fisher, 1950).

Results and Discussion

TSS and total sugar

It is evident from the data (Table 1) that TSS and total sugar content of stored guava pulp was increased with the advancement of storage period in all the treatments. The mean maximum TSS and total sugar content were recorded in the frozen storage treatment T_9 (13.03^0B and 7.76 %) followed by T_1 (12.46^0B and 7.67 %) and minimum in T_6 (11.78^0B and 7.16 %) during the storage. The increment in TSS content of preserved guava pulp during storage was probably due to conversion of free polysaccharides (starch) into monosaccharide (Jain *et al.* 2007). TSS and total sugar content during storage have positive proportional trend (Desai *et al.*, 2012 in mango pulp and Chand and Gehlot, 2006 in *bael* pulp). Varietal influence was also

evident from the same table that TSS (12.55 ^{0}B) and total sugar (8.00 %) content of L-49 variety was higher during entire storage period over Lalit. Probably it might be due to Lalit variety comparatively contains more acidity than L-49 that maintain lower TSS content and total sugar during storage. The present study is in the agreement with Jain *et al.*, (2007) in guava pulp and Kumar *et al.*, (2015) in *ber* pulp.

Acidity and pH

The results indicate that the acidity of preserved guava pulp was increased and pH was decreased slightly with the advancement of storage period (Table 2). The mean maximum acidity (0.585%) was recorded in the treatment T_6 (PS@0.025%) and minimum (0.555%) was in the frozen storage treatment (T_9). In pH vice versa value was observed from acidity *i.e.*, maximum in treatment T_9 (3.99) and minimum in T_6 (3.66) treatment. The increment in acidity of preserved guava pulp during storage period was due to formation of organic acids by degradation of ascorbic acids (Bal *et al.*, 2014) and decrease in pH might be due to the formation of free acids and pectin hydrolysis (Ahmad *et al.*, 2000).

Variety Lalit (0.574 %) recorded higher mean acidity and lower pH value (3.77) compare to the variety L-49 (0.560 % acidity and 3.89 pH). Probably it might be due to varietal characteristics like variety Lalit contain low TSS and higher acidity compare to L-49. Present study was in the agreement with the Ahmad *et al*., (2000) observed that decrease in pH of guava pulp during storage.

Ascorbic acid and reducing sugar

Ascorbic acid content of guava pulp was decreased with advancement of storage period. The maximum ascorbic acid content was retained in treatment T_9 (frozen storage) *i.e.*, 135.63 mg 100g^{-1} followed by T_1 (129.25 mg 100g^{-1}) and minimum in treatment T_6 (PS@0.025%) *i.e.*, 88.25 mg 100g^{-1} at the end of storage period (90th days). Decrease in ascorbic acid content was due to the oxidation of ascorbic acid to de hydro ascorbic acid and then further degraded to 2, 3-diketo-gluconic acid by the action of ascorbic acid oxidase enzyme.

Mean ascorbic acid contain in the variety L-49 (136.91 mg 100g^{-1}) higher over Lalit (127.74 mg 100g^{-1}) throughout the storage period, but decreased with advancement of storage period in both the varieties. The present study is in the cognizance with the findings of Bons *et al.*, (2011).

Reducing sugar

Same table also explicated that increment in reducing sugar with the advancement of storage period in all the treatments (Table 3), maximum reducing sugar content was recorded from treatment T_9 (frozen storage) *i.e.*, 6.47 per cent followed by T_1 (6.45 %) and minimum in treatment T_6 (PS@0.025%) *i.e.*, 6.09 per cent at the end of storage days. It might be due to breakdown of some of the hemicelluloses and other saccharides into simple soluble sugars. Same table also evident that guava variety Lalit recorded significantly lower reducing sugar as compared to L-49 and their respective mean value were 4.39 and 5.14, respectively. Variety Lalit has low reducing sugar probably due to lower amount of TSS as compared to L-49 variety. The present study supported by the findings of Tandon and Kalra (1984) in guava pulp and Desai *et al*., (2012) in mango pulp.

NEB and L colour value

NEB: Non enzymatic browning of guava pulp was increased with advancement of storage

period. The minimum NEB was recorded in T_9 (0.059, 0.114 and 0.238) followed by T_1 (0.059, 0.119 and 0.218) and maximum in treatment T_6 (0.063, 0.134 and 0.359) at 30, 60 and 90th days of storage. It might be due formation of furfural and its derivatives at high temperature formed by reaction of ascorbic acid with citric acid. These derivatives could have contributed to non-enzymatic browning which were higher at high temperature. Low non-enzymatic browning in treatment T_1 might be due to better antioxidant action of KMS and more non-enzymatic browning in T_6 could be due to Millard and Caramelization reactions.

Same table also revealed that both variety show increasing trend in NEB with the advancement of storage period. It was recorded that NEB from L-49 was higher as compared to Lalit. At 90th days of storage period, recorded NEB from L-49 (0.283) and from Lalit (0.252). The present study supported by Bons *et al.,* (2013) in guava pulp and Sarolia and Mukherjee (2002) in lime juice.

Colour *L** value

At 60 and 90 days of storage luminosity value of guava pulp was recorded maximum in T_9 (43.40 and 36.44, respectively) closely followed by T_1 (41.76 and 35.55, respectively) and minimum in T_6 (37.53 and 28.22, respectively) treatment. Same table also explicated that mean luminosity (*L**) for variety L-49 (42.71) contained higher as compared to Lalit (40.01). Luminosity of both the cultivars decreased with the advancement of storage duration due to higher non enzymatic browning showed increasing trend with the storage duration.

Table.1 Effect of preservation methods and varieties on TSS and total sugar content of guava pulp during storage

Treatments	**Storage duration (days)**							
	TSS (^{0}B)				Total sugar (%)			
	30	60	90	Mean	30	60	90	Mean
Preservation methods								
T_1 (KMS-0.1%)	12.09	12.41	12.90	12.46	6.47	7.62	8.92	7.67
T_2 (SB-0.1%)	11.90	12.24	12.45	12.19	6.35	7.50	8.78	7.54
T_3 (SB+KMS -0.05%)	12.06	12.33	12.65	12.34	6.44	7.59	8.89	7.64
T_4 (PS+SB-0.05%)	11.66	12.06	12.29	12.00	6.31	7.46	8.74	7.50
T_5 (PS+KMS-0.05%)	11.70	12.11	12.33	12.04	6.33	7.48	8.77	7.52
T_6 (PS- 0.025%)	11.35	11.94	12.07	11.78	6.23	7.08	8.18	7.16
T_7 (PS-0.05%)	11.56	12.05	12.24	11.95	6.29	7.44	8.72	7.48
T_8 (PS-0.1%)	12.00	12.27	12.53	12.26	6.39	7.54	8.85	7.59
T_9 (Deep Freeze (-20^{0}C)	12.59	12.91	13.58	13.02	6.51	7.76	9.01	7.76
C.D. (P=0.05)	NS	0.468	0.713		NS	0.154	0.194	
Varieties								
V_1 (Lalit)	11.62	11.91	12.19	11.90	6.15	6.90	8.18	7.07
V_2 (L-49)	12.14	12.60	12.92	12.55	6.59	8.09	9.34	8.00
C.D. (P=0.05)	0.365	0.221	0.336		0.106	0.073	0.091	

Table.2 Effect of preservation methods and varieties on acidity and pH content of guava pulp during storage

Treatments	Storage duration (days)							
	Acidity (%)				pH			
	30	60	90	Mean	30	60	90	Mean
Preservation methods								
T_1 (KMS-0.1%)	0.452	0.542	0.672	0.555	4.03	3.95	3.80	3.93
T_2 (SB-0.1%)	0.460	0.548	0.697	0.568	3.94	3.87	3.82	3.88
T_3 (SB+KMS -0.05%)	0.453	0.545	0.683	0.560	3.95	3.91	3.78	3.88
T_4 (PS+SB-0.05%)	0.466	0.555	0.698	0.573	3.90	3.78	3.66	3.78
T_5 (PS+KMS-0.05%)	0.465	0.553	0.696	0.571	3.89	3.81	3.70	3.80
T_6 (PS- 0.025%)	0.472	0.562	0.722	0.585	3.76	3.70	3.52	3.66
T_7 (PS-0.05%)	0.464	0.557	0.704	0.575	3.85	3.75	3.59	3.73
T_8 (PS-0.1%)	0.458	0.547	0.685	0.563	3.96	3.87	3.72	3.85
T_9 (Deep Freeze (-20^{0}C)	0.451	0.539	0.672	0.554	4.11	4.01	3.85	3.99
C.D. (P=0.05)	0.0120	0.0137	0.0242		0.170	0.161	0.154	
Varieties								
V_1 (Lalit)	0.465	0.555	0.703	0.574	3.88	3.78	3.64	3.77
V_2 (L-49)	0.455	0.544	0.682	0.560	3.99	3.92	3.77	3.89
C.D. (P=0.05)	0.0057	0.0065	0.0114		0.080	0.076	0.072	

Table.3 Effect of preservation methods and varieties on ascorbic acid and reducing sugar content of guava pulp during storage

Treatments	Storage duration (days)							
	Ascorbic acid (mg 100g^{-1})				Reducing sugar (%)			
	30	60	90	Mean	30	60	90	Mean
Preservation methods								
T_1 (KMS-0.1%)	163.00	149.25	129.25	147.17	3.34	4.73	6.45	4.84
T_2 (SB-0.1%)	152.38	137.13	106.38	131.96	3.25	4.65	6.37	4.76
T_3 (SB+KMS -0.05%)	156.50	141.50	112.75	136.92	3.32	4.72	6.43	4.72
T_4 (PS+SB-0.05%)	145.50	130.50	100.13	125.38	3.22	4.64	6.35	4.74
T_5 (PS+KMS-0.05%)	149.38	134.88	104.63	129.63	3.23	4.65	6.36	4.75
T_6 (PS- 0.025%)	132.38	117.63	88.25	112.75	3.19	4.51	6.09	4.60
T_7 (PS-0.05%)	140.25	124.75	97.25	120.75	3.21	4.63	6.34	4.73
T_8 (PS-0.1%)	153.00	137.25	108.00	132.75	3.29	4.68	6.43	4.80
T_9 (Deep Freeze (-20^{0}C)	170.63	155.63	135.63	153.96	3.36	4.75	6.47	4.86
C.D. (P=0.05)	6.05	5.86	5.25		NS	0.114	0.126	
Varieties								
V_1 (Lalit)	147.00	132.00	104.22	127.74	3.10	4.11	5.96	4.39
V_2 (L-49)	155.67	141.00	114.06	136.91	3.44	5.21	6.77	5.14
C.D. (P=0.05)	2.85	2.76	2.47		0.066	0.054	0.059	

Table.4 Effect of preservation methods and varieties on NEB and colour L*value of guava pulp during storage

Treatments	Storage duration (days)							
	NEB (nm)				Colour L^*			
	30	60	90	Mean	30	60	90	Mean
Preservation methods								
T_1 (KMS-0.1%)	0.0596	0.1195	0.218	0.132	53.89	41.76	35.51	43.72
T_2 (SB-0.1%)	0.0614	0.1208	0.259	0.147	50.97	39.97	32.97	41.30
T_3 (SB+KMS -0.05%)	0.0601	0.1234	0.233	0.139	52.16	41.03	34.28	42.49
T_4 (PS+SB-0.05%)	0.0625	0.1243	0.273	0.153	50.00	39.00	30.25	39.75
T_5 (PS+KMS-0.05%)	0.0632	0.1296	0.294	0.162	50.66	39.66	31.29	40.54
T_6 (PS- 0.025%)	0.0636	0.1343	0.359	0.186	48.53	37.53	28.22	38.09
T_7 (PS-0.05%)	0.0635	0.1308	0.324	0.173	50.01	39.01	30.01	39.68
T_8 (PS-0.1%)	0.0608	0.1233	0.238	0.141	51.72	40.72	33.47	41.97
T_9 (Deep Freeze (-20^{0}C)	0.0593	0.1144	0.209	0.128	54.31	43.40	36.44	44.72
C.D. (P=0.05)	0.0013	0.0040	0.011		NS	1.850	1.875	
Varieties								
V_1 (Lalit)	0.0608	0.122	0.252	0.145	50.05	38.83	31.16	40.01
V_2 (L-49)	0.0623	0.126	0.283	0.157	52.67	41.64	33.82	42.71
C.D. (P=0.05)	0.0006	0.0018	0.0011		1.729	0.872	0.884	

Table.5 Effect of preservation methods and varieties fungal and bacterial growth (cfu g-1) of guava pulp during storage

Treatments	Storage duration (days)							
	Fungus (cfu X 10^4 g^{-1})				Bacteria (cfu X 10^6 g^{-1})			
	30	60	90	Mean	30	60	90	Mean
Preservation methods								
T_1 (KMS-0.1%)	1.6	2.5	4.7	2.9	1.5	2.2	3.8	2.5
T_2 (SB-0.1%)	1.7	3.9	5.8	3.8	1.7	3.0	4.6	3.1
T_3 (SB+KMS -0.05%)	3.1	5.3	8.0	5.5	2.4	3.8	6.1	4.1
T_4 (PS+SB-0.05%)	2.5	4.1	6.5	4.4	2.0	3.1	5.0	3.4
T_5 (PS+KMS-0.05%)	2.7	4.6	7.0	4.8	2.1	3.6	5.6	3.8
T_6 (PS- 0.025%)	3.4	6.3	9.4	6.4	2.7	5.2	8.0	5.3
T_7 (PS-0.05%)	3.1	6.3	8.8	6.1	2.3	4.8	7.3	4.3
T_8 (PS-0.1%)	2.0	3.1	5.3	3.5	1.6	2.7	4.1	2.8
T_9 (Deep Freeze (-20^{0}C)	1.7	2.5	4.1	2.8	1.5	2.0	3.3	2.3
C.D. (P=0.05)	2.20	2.07	3.69		0.73	1.52	2.08	
Varieties								
V_1 (Lalit)	2.3	4.2	6.4	4.3	1.9	3.2	5.2	3.4
V_2 (L-49)	2.5	4.3	6.7	4.5	2.0	3.4	5.3	3.6
C.D. (P=0.05)	1.04	0.97	1.74		0.34	0.72	0.98	

Microbial counts

Total fungal and bacterial growth in preserved guava pulp was increased with the advancement of storage period (Table 5). The maximum fungal growth was recorded in the treatment T_6 (PS@0.025%) *i.e.*, 9.4 and minimum was in the frozen storage treatment (T_9) *i.e.*, 4.1. In bacterial growth same trend was observed maximum in treatment T_6 (5.3) and minimum in T_9 (2.3) treatment.

It can't be stopped but can be inhibit by using preservatives. Sodium benzoate and potassium meta bi- sulphite (KMS) are most commonly used for long term storage as they have show better antimicrobial activity (Sofos *et al.*, 1981; Mangnelli *et al.*, 1983; Luck *et al.*, 1990). The present study was in agreement with Ayub *et al.*, (2010) in strawberry juice and Khattak *et al.*, (2014) in apricot pulp.

Variety L-49 recorded higher mean fungal and bacterial growth *i.e.*, 4.5 and 3.6, respectively while Lalit recorded minimum mean fungal and bacterial growth *i.e.*, 4.3 and 3.4, respectively. The probable reason might be due to Lalit variety relatively acidic with low pH compare to L-49 that suppresses the fungal and bacterial growth. The present study supported by Akhtar *et al.*, (2010) in mango pulp.

Thus, guava pulp preservation under low temperature (-20^0C) gave superior quality and better storage life during the storage but in economic point of view preservative potassium meta bi sulphite @ 0.1 % followed by potassium sorbate @ 0.1 % may be used for the same at ambient temperature (32+4 ^{0}C).

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