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Effect of xanthan gum on storage stability and sensory attributes of guava squash

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SUMMARY : **A study was undertaken to produce a stable and organoleptically preferred guava squash with proper suspension of fruit pulp. This was done by supplementing the squash with xanthan gum, an exocellular polysaccharide produced by obligatory aerobic microorganism, *Xanthomonas campestris*. Squash of guava cv. 'Allahabad Safeda' was prepared with 25 per cent pulp, 40^0B (Brix) T.S.S. (Total soluble solids), 1 per cent acidity and with different concentration levels (0.1 to 0.5 per cent) of xanthan gum. The prepared recipies were subjected to physico-chemical analysis at 0, 30, 60, 90, 120, 150 and 180 days of storage and sensory evaluation at 180 days of storage. An increasing trend in pH and total soluble solids and decreasing trend in titrable acidity and ascorbic acid was noticed during storage period. Viscosity of the squash decreased with increase in temperature. Guava squash containing 0.1 per cent xanthan gum, 25 per cent pulp, 40^0B T.S.S and 1 per cent acidity was found to be the best recipe for overall acceptability.**

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Guava (*Psidium guajava* L.), called 'apple of the tropics', is one of the most common fruits in India. It is quite hardy, prolific bearing and healthy remunerative sub-tropical fruit. It thrives on all types of soils but sensitive to water logging conditions (Bose *et al*., 2001). Guava is commercially cultivated in gangetic alluvial zones north and south Parganas, Nadia, and Murshidabad district and lateritic zones of Paschim, Medinipur and Birbhum district covering an area of nearly 8.27 thousand hectares (Anonymous, 2004). Fruit of guava contains 82.50 per cent water, 4.45 per cent reducing sugars, 9.73 per cent total soluble solids, 0.48 per cent ash, 260 mg vitamin C /100g of fruit and 2.45 per cent acidity (Phandis, 1970).

Guava fruit is available twice in a year–in rainy season and in winter. It is plentiful during the rainy season and its disposal becomes a serious problem. Its utilization is very little in processing industry. Jam and jelly manufactured from guava pulp are not acceptable like other fruit products because of their gritty texture (Ramanarao *et al*., 1956). This gritty texture is due to the presence of corky cells in the pulp. Guava can be processed into potential fruit beverage because of its excellent flavour and nutritive value. The fruit beverages are becoming popular in comparison to synthetic or aerated drinks.

Keeping the above facts in view, the present study was undertaken to utilize guava fruit in the development of value added squash with proper suspension of fruit pulp by supplementing the soluble dietary fibre in the form of xanthan gum. This would result in better utilization of guava fruit by the processing industry and minimizing the loss of guava fruits during the rainy season.

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EXPERIMENTAL METHODS

Guava (cv. Allahabad Safeda) was procured from local Barajaguli market of Kolkata. Fruits with the same level of maturity, ripe and firm, free from blemishes and bruises were carefully selected for the study. Guava squash was prepared as described in flow chart (Fig.A) with the following recipies.

Table A : Recipies for guava squash

Recipie No.	Pulp content (%)	TSS (^{0}Brix)	Acidity (%)	Xanthan gum (%)
G_1	25	40	1.0	0.0
G_2	25	40	1.0	0.1
G_3	25	40	1.0	0.2
G_4	25	40	1.0	0.3
G_5	25	40	1.0	0.4
G_6	25	40	1.0	0.5

Guava fruits were washed and sorted
↓
Sliced into small pieces of 2 – 2.5 cm sizes with the stainless knife while immersed in water
↓
Fruit slices in water were given heat treatment at 74 – 75^{0}C for (2 – 5 minutes)
↓
Small pieces were mashed in a grinder with filtered water in proportions of 1: 3 by weight (Guava Slices / Water, w/v)
↓
Pulp thus obtained was passed through a muslin cloth.
↓
Total soluble solids were measured in extracted juice
↓
Xanthan gum was added to the extracted juice
↓
Syrup was prepared by mixing the water and acid
↓
The juice was added to the syrup and mixed well
↓
Preservative (Potassium metabisulphite (KMS), 350 ppm) was added.
↓
Prepared squash was filled into pre-sterilized bottles of 200 ml capacity (Sterilization was done at 25lb/inch for 15 minutes)
↓
Guava squash was heated to 85^{0}C
↓
Capping was done
↓
Product was processed in boiling water for 20 minutes and cooled immediately.
↓
Bottles were stored at room temperature (18 – 25^{0}C) for further observation

Fig. A : Preparation scheme for guava squash

The prepared squash recipies were subjected to physico-chemical analysis at 0, 30, 60, 90, 120, 150 and 180 days of storage and sensory evaluation at 180 days of storage.

The pH was recorded with Toshniwal digital pH meter (Model D_I 707). Total soluble solids content was recorded with Erma hand refractometer. Acidity (as citric acid) was estimated by titration method (Ranganna, 1977). Ascorbic acid was determined by 2, 6-dichlorophenol indophenol titration method (Ranganna, 1986). Viscosity is one of the important rheological characters of liquid foods which offer resistance to flow. The viscosity in fresh guava squash was determined over a range of temperature (30^0–50^{0}C) as well as at constant concentration (40^{0}Brix) by using the viscometer bath (Model No. - SVB, S.L. No.-S/01 Simco Brand, Kolkata, West Bengal) and capillary viscometer tube (Cannon fenske viscometer).

Guava squash was evaluated at 180 days of storage for sensory attributes such as appearance, aroma and flavour, taste and overall acceptability by a panel of 8 judges by numerical scoring method (Amerine *et al.*, 1965). The prepared product was observed for mould growth by visual methods at monthly intervals throughout the storage period.

In this experiment, factorial completely randomized design (factorial CRD) was adopted. The data were analyzed and main interaction effects were presented (Sundararaj *et al.,* 1972). Observations on various parameters were recorded with three replications and significance was tested using F-test method.

EXPERIMENTAL FINDINGS AND ANALYSIS

Physico-chemical parameters of guava fruits (cv. Allahabad safeda) selected for the study were estimated and presented (Table 1). The colour of the fruits was light greenish yellow. The average diameter, height, weight of seed and weight of fruits were found to be 6.91 cm, 6.56 cm, 0.92g/100g and 150.5g, respectively. pH recorded was 1.10. The chemical analysis indicated that fresh guava pulp had the total soluble solids of 8^{0}Brix while, acidity and ascorbic acid were 0.4, and 155.8 mg/100g, respectively.

Table 1 : Physico-chemical parameters of guava fruits Cv. Allahabad Safeda (n=10)

Sr. No.	Parameters	Observation
1.	Colour	Light greenish yellow
2.	Diameter (cm)	6.91 ± 0.3
3.	Height (cm)	6.56 ± 0.3
4.	Fruit weight(g)	150.5 g ± 0.8
5.	Seed weight (g/100g)	0.92
6.	pH	1.1
7.	Total soluble solids (^{0}Brix)	8.0
8.	Acidity as citric acid (%)	0.4
9.	Ascorbic acid (mg/100g)	155.8

An increasing trend in total soluble solids content of guava squash was observed during storage period of 180 days (Table 2). Hydrolysis of polysaccharides like starch, cellulose and pectin substances into simpler substances resulted in increase of total soluble sugars and soluble solids. This indicates that during storage there was change in pulp composition. Increase in total soluble solids content during storage was reported in amla squash Reddy and Chikkasubbanna, 2008) and nectar of muskmelon (Katiyar *et al.*, 1967).

Table 2 : Influence of different levels of xanthan gum and storage period and their interaction on TSS, pH, acidity and ascorbic acid in guava squash

Description	TSS (^{0} Brix)	pH	Acidity (%)	Ascorbic acid(mg/100)
Initial values	40	2.74	1.0	37.18
Xanthangum levels (%)				
0.0 (G_1)	42.91	3.49	0.80	27.05
0.1 (G_2)	42.20	3.21	0.82	29.63
0.2 (G_3)	42.18	3.16	0.83	29.70
0.3 (G_4)	41.70	3.10	0.88	31.64
0.4 (G_5)	40.67	3.10	0.88	34.83
0.5 (G_6)	40.09	2.95	0.91	33.85
F test	*	*	*	*
S.Em (±)	0.02	0.01	0.01	0.30
CD at 5%	0.08	0.02	0.03	0.84
Storage in days				
30 days (D_1)	40.30	2.80	0.971	35.68
60 days (D_2)	40.82	2.92	0.944	33.59
90 days (D_3)	41.49	3.01	0.746	31.25
120 days (D_4)	41.79	3.17	0.839	30.14
150 days(D_5)	42.38	3.40	0.836	28.68
180 days (D_6)	42.96	3.71	0.812	27.36
F test	*	*	*	*
S.Em (±)	0.03	0.01	0.01	0.30
CD at 5%	0.08	0.02	0.03	0.84
Interaction				
$G_1 \times$ D1	40.50	2.81	0.96	33.63
$G_1 \times D_2$	41.44	2.88	0.94	29.30
$G_1 \times D_3$	42.46	3.00	0.92	27.60
$G_1 \times D_4$	43.16	3.13	0.89	26.46
$G_1 \times D_5$	44.53	3.45	0.88	24.46
$G_1 \times D_6$	45.37	3.71	0.85	23.86
$G_2 \times D_1$	40.41	2.78	0.97	35.47
$G_2 \times D_2$	41.67	2.82	0.94	33.93
$G_2 \times D_3$	42.23	2.89	0.90	32.60
$G_2 \times D_4$	42.78	3.14	0.86	31.63
$G_2 \times D_5$	43.13	3.32	0.84	30.04
$G_2 \times D_6$	44.06	3.67	0.80	29.13
$G_3 \times D_1$	40.37	2.78	0.96	34.47
$G_3 \times D_2$	41.00	2.83	0.93	33.80
$G_3 \times D_3$	42.13	2.89	0.89	32.96
$G_3 \times D_4$	42.53	3.14	0.87	31.70
$G_3 \times D_5$	43.09	3.30	0.83	29.65
$G_3 \times D_6$	44.00	3.66	0.80	27.30
$G_4 \times D_1$	40.36	2.83	0.95	34.97
G4 × D_2	40.86	3.02	0.89	33.38
G4 × D_3	41.50	3.12	0.85	31.78
G4 × D_4	41.96	3.37	0.81	30.65
G4 × D_5	42.40	3.73	0.76	29.71
G4 × D_6	43.10	3.86	0.74	28.37

Table 2 : Contd……

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$G_4 \times D_1$	40.20	2.81	0.96	35.08
$G_5 \times D_2$	40.90	2.98	0.89	33.65
$G_5 \times D_3$	41.56	3.17	0.85	32.15
$G_5 \times D_4$	42.03	3.30	0.81	31.23
$G_5 \times D_5$	42.96	3.46	0.79	30.46
$G_5 \times D_6$	43.26	3.53	0.74	28.91
$G_6 \times D_1$	40.00	2.81	0.96	35.17
$G_6 \times D_2$	40.96	3.00	0.93	33.18
$G_6 \times D_3$	41.30	3.16	0.86	31.41
$G_6 \times D_4$	42.16	3.43	0.78	30.17
$G_6 \times D_5$	42.83	3.53	0.74	29.08
$G_6 \times D_6$	43.13	3.66	0.72	28.11
F test	*	*	*	*
S.Em (±)	0.07	0.03	0.03	0.74
CD at 5%	0.20	0.07	0.08	2.05

Guava squash showed an increase in pH during storage. Xanthan gum level and storage time interaction significantly affected the pH. The increase in pH of guava squash during storage could be attributed to acid hydrolysis of polysaccharides and non-reducing sugars to hexose sugars (reducing sugars) or complexing in the presence of metal ions as reported in amla squash (Reddy and Chikkasubbanna, 2008) and aonla juice (Gajanana, 2002).

Acidity of guava squash witnessed a decreasing trend during storage period. This might be attributed to utilization of acid for hydrolysis of polysaccharides and non-reducing sugars to convert them to hexose sugars (reducing sugars) or complexing in the presence of metal ions. The declining trend might also be due to chemical interaction among the chemical constituents of juice induced by temperature influencing enzymatic action (Palaniswamy and Muthukrishnan, 1974). Bhatia *et al.* (1956) reported that degree of reduction in acidity is depending on concentration of sugar and is a general phenomenon during storage of beverages in the presence of sugars. Reduction in acidity during storage was noticed by Reddy and Chikkasubbanna (2009) in amla syrup and Bhatnagar *et al.* (1984) in muskmelon jam.

A declining trend in the ascorbic acid content of guava squash was noticed during storage. Both ascorbic acid and dehydroascorbic acid are highly volatile and unstable forms of vitamin-C.The decline in ascorbic acid concentration could be due to thermal degradation during processing and subsequent oxidation in storage as it is very sensitive to heat, pressure treatment and light (Brock *et al.*, 1998).Similar observations were made in amla squash (Reddy and Chikkasubbanna, 2008) and amla jam (Reddy and Chikkasubbanna, 2009).

Viscosity of the guava squash increased as concentration of xanthan gum increased (Table 3). The viscosity of xanthan gum solutions increases strongly with increasing concentration of the polymer. This behaviour is attributed to the intermolecular interaction or entanglement, increasing the effective macromolecule dimensions and molecular weight (Garcia-Ochoa *et al.*, 2000).There was significant decrease in viscosity as temperature increased. The reason is that the viscosity of liquids is due to intermolecular cohesion and this cohesion decreases with increases in temperature.

Table 3: Variation in viscosity with varied levels of xanthan gum at three levels of temperature (30^0C, 40^0C and 50^0C) in guava squash

Xanthangum levels (%)	Viscosity (pa-sec) Temperature (in °C)		
	30°	40°	50°
0.0 (G_1)	0.207	0.173	0.030
0.1 (G_2)	0.700	0.600	0.417
0.2 (G_3)	1.197	0.897	0.700
0.3 (G_4)	1.740	1.330	1.027
0.4 (G_5)	1.950	1.560	1.200
0.5 (G_6)	2.847	2.427	1.647
F test	*	*	*
S.Em (±)	0.011	0.011	0.011
CD at 5%	0.031	0.031	0.031

Overall acceptability of guava squash prepared with 25 per cent pulp, 40^0B T.S.S and 1 per cent of acidity was significantly higher at 0.1 per cent of xanthan gum followed by 0.2 per cent (Table 4). Guava squash prepared with different treatment combinations was found completely free from spoilage due to higher total soluble solids and effective processing of the product. Addition of xanthan gum in beverages at concentrations up to 0.5 per cent W/W can help in the stabilization and mouth feel of the product (Nussinovitch, 1997). The useful properties of gums are largely due to the physical effects, and primarily involves those dealing with their interaction with water. Gum interacts with protein molecules to provide suspension and solution stability, while it provides viscous and emulsification effects due to lipid molecules. By such interactions, gums perform their useful functions, which are mainly those relating to provision of the viscosity, solution stability and suspend ability (Glicksman 1982).

Table 4: Organoleptic scores of guava squash at 180 days of storage

Xanthan gum levels (%)	Organoleptic scores			
	Aroma & flavor	Colour & appearance	Taste	Overall acceptability
0.0 (G_1)	1.28	1.23	1.75	1.00
0.1 (G_2)	3.52	3.58	3.16	3.37
0.2 (G_3)	3.50	3.30	2.50	3.02
0.3 (G_4)	3.56	2.81	2.22	2.42
0.4 (G_5)	3.61	2.61	1.73	2.13
0.5 (G_6)	3.72	2.48	1.23	2.05
F test	*	*	*	*
S.Em (±)	0.08	0.11	0.08	0.11
CD at 5%	0.23	0.32	0.23	0.30

Results indicate that addition of xanthan gum positively impart on the stability and acts as emulsifier to the product and also acts as dietary fibre which is helpful from consumer point of view.

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