Textural characteristics of guava at different stage of maturity

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Abstract

Textural properties data of guava are important in adoption and design of various handling, packaging and transportation systems. Textural properties namely, bio yield point, flesh firmness, fracture energy and total energy, penetration force compression area, shear energy were determined with respect to maturity stage under immature, mature and over mature conditions as well as storage temperatures under ambient condition (25°C) and low temperature condition (6°C). Bio yield point, flesh firmness, fracture energy and total energy decreased with increased maturity and storage temperatures. At the end of 7th day storage, bio yield point, flesh firmness, fracture energy and total energy gradually decreased respectively. All textural properties were significantly higher in low temperature (6°C) in ambient condition (25°C).

Keywords: Textural Properties; Bio Yield Point, Flesh Firmness, Fracture Energy, Total Energy

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Introduction

In many agricultural products, firmness is related to maturity. Generally firmness of fruits decreases gradually as they become more mature and decreases rapidly as they ripen. Overripe and damaged fruits become relatively soft. Thus firmness can be used as a criterion for sorting agricultural products into different maturity groups or for separating overripe and damaged fruits from good ones. Several methods for measuring fruit firmness have been developed. Firmness is not a physical quantity, however, is strongly related to numerous physical properties. Maturity at harvest is the most important factor that determines post-harvest-life and final quality of fruit and vegetables. In which texture is a quality attribute that is critical in determining the acceptability of fruits and vegetables. Texture is a collective term that encompasses the structural and mechanical

properties of a fruits and vegetables and their sensory perception in the hand or mouth.

The post harvest textural properties data of fruits and vegetables are important in adoption and design of various handling, packaging storage, and transportation systems. The fruits compression test simulates the condition of static loading that can withstand in mechanical handling and storage. The most common practices to determine the fruit ripeness in field situation is pressing with ball of thumbs. Force deformation characteristics of fruits beyond the elastics limit may be important may be important to simulate the destruction that occurs in bruising. Elastic modulus or Young modulus is often used by engineers as an index of product firmness. Puncture tests are also measures of firmness of fruits and vegetable to estimate harvest maturity or post harvest evaluation of firmness.

Research has been carried out for several years to determine the resistance of fruits and vegetables to compression force. Ahmed *et al.*, (1973) reported shear stress data of peel piece collected at the time of harvest. Fruit softening is often storage as a criterion for estimating the feasibility of their storage or shelf life (Kader, 1992; Polderdijk *et al.*, 1993; and Blankenship *et al.*, 1997).

In most fruits, their firmness diminishes as the degree of maturation increases due to the action of pectic enzymes during fruit maturation (Muramatsu *et al.*, 1996). Miller (1987) determined stress index, modulus of elasticity, and rupture force of freeze-damaged and non damaged fruit. Sarig and Nahir (1973) reported the initial and permanent deformations of a creep test of citrus fruit to indicate firmness. Churchill *et al.*, (1980) determined the influence of harvest date on the physical strength properties (burst and puncture) of whole fruit and tensile strength of peel pieces of three orange varieties. Singh (1971) studied optimum storage temperature, storage life and keeping quality of mandarins and sweet lemon. During storage the loss of moisture from the peel is continuously replenished by the movement of the moisture from the pulp. If this loss due to combined effect of respiration and transpiration goes on unchecked, the fruit shrivels up and becomes unmarketable.

There is the dearth of information on textural properties changes of guava at different maturity stage under ambient and refrigerated storage conditions which are helpful to decide handling, packaging, storage, and transportation systems to be adopted and their designs. The objective of this paper is to report changes in basic textural properties of whole guava at different maturity stage under ambient and refrigerated fruit storage conditions.

Materials and Methods

Guava fruits were procured from experimental University Horticulture Farm, Rajasthan College of Agriculture, Udaipur, Rajasthan, India. Random samples were drawn from a freshly harvested lot of guava at the time of harvest. Fruits were divided into two lots each lot of fruits was taken into box and kept in an ambient condition of 25° C and 38 % RH. Another lot of fruits were kept in low temperature of 6° C and 88 % RH. Textural properties of guava were determined with respect to the maturity to the storage period in both ambient and low temperature.

Water activity of guava: About 5g of cut guava sample was taken into plastic container and determined with water activity meter at the time of experimentation. The average values of three replications are reported.

Puncture test: For measurement of puncture test, the Texture Analyzer was fitted with 5 mm cylindrical probe to the probe carrier. Guava was placed upon a flat plate and the test was carried out at the probe speed of 0.1 mm /s. The maximum force required to make the puncture on the fruit surface was taken from the force – deformation curve as shown in (Fig 1). The textural properties were measured with 20 fruits (replications) and average values are reported for both ambient and low temperature for 7 days storage period.

Compression test: Guava fruit was set upon a flat base plate of Texture Analyzer. Probe carrier was fixed with 75 mm diameter flat plate and brought in contact with the fruit. A 500 kg load cell was used for experiment. Compression force was applied at a speed of 0.1 mm/s to compress the fruit for 25 mm from the contact point. The bio yield point was considered as the force under the prescribed conditions, required to cause permanent deformation indicated by the peak force before the sudden drop as shown in a

force – deformation curve (Fig. 2). The flesh firmness was expressed as the force in kg required to compress the fruit to 25 mm distance. The average values are reported for three maturity as well as both ambient (25° C) and low temperature (6° C) for 7 days storage period.

Cutting test: Blade set with knife of Texture Analyzer was attached to probe carrier. Guava fruit was positioned, cutter speed was 0.1 mm / s was used with 500 kg load cell. The load against depth of cut was recorded continuously. Sample data generated by a fruit cutting force were taken as the peak force. The total fruit cutting energy was considered as the total area under the force –deformation curve as shown in Fig. 3. The average values are reported for three maturity as well as both ambient and low temperature for 7 days storage period

The following setting was used for the texture analysis

Texture analysis setting

Version: 07, 13 H load cell 5 x 10² kg

Test mode and option

Measure force in Compression

Repeat until count

Parameters

Pre – Test – Speed	:	2.00 mm/s
Test Speed	:	0.1 mm/s
Post Test Speed	:	2.00 mm/s
Distance	:	25 mm
Stop plot	:	Start position

Trigger

Trigger	:	Auto
Trigger Force	:	50.00 g

Probe

5mm diameter cylinder probe (puncture test)

75mm compression plate (compression test)

Blade set with knife (cutting test)

Fig.1: A typical force- time curve for puncture of whole guava (5 mm diameter cylinder probe)

Fig. 2: A typical force – deformation curve for guava under 75 mm compression probe

Fig. 3: A typical force – deformation curve for whole guava cutting with a BSK probe

Results and discussion

Water activity: Water activity of guava fruit at the time of harvest was 0.991, 0.976 and 0.975 at immature, mature and over mature stages respectively. At the end of 7

days of storage it was observed 0.826, 0.815 and 0.803 at same maturity stage under ambient condition. However, at low temperature, it was 0.996, 0.989 and 0.982 at immature, mature and over mature stage

after 7th day storage it was observed that 0.887, 0.843 and 0.878.

Puncture test of guava: Guava puncture force, flesh firmness generally decreased with storage periods under both refrigerated temperature and ambient storage condition (Table 1). Puncture force of guava slightly decreased from 6.82 kg to 0.48 kg in both refrigerated and ambient conditions at immature guava fruit. The rupture force was observed to be higher in orange stored under refrigerated condition than that under ambient condition. However, the decrease in all the textural parameter with storage period was statistically significant at 5% level.

Guava compression test: Firmness values of guava fruit slowly decreased during immature to over mature fruit under both ambient and low storage conditions (Table 2). The decrease in bio yield point, flesh firmness and compression energy was more pronounced under ambient condition than that under low temperature condition. This might be because at low temperatures, fruit ripens slowly because of a metabolic delay, consequently, fruit softening is also delayed. Higher temperature promotes transpiration and ripening, a fast decrease in bio yield

point, flesh firmness and compression energy being more representative signs of these processes.

Guava cutting test: Cutting force, flesh firmness and cutting energy for whole guava data are presented in Table 3. Peak cutting force, flesh firmness and cutting energy decreased from 14.83 kg to 5.59 kg and 3.82 kg to 2.29 kg for whole immature and mature guava in ambient condition. Further, it decreased from 2.06 kg to 1.02 kg for over matured guava. The Peak cutting force and peel cutting energy decreased from 79.5 to 66.3 N and 240.7 to 165.3 J respectively under refrigerated condition. However, the decrease in peak cutting force with storage period was non-significant at $P > 0.05$ in both ambient as well as in refrigerated conditions. But decrease in peel cutting energy with storage period was significant at $P > 0.05$ in both of the cases, ambient as well as refrigerated conditions. The peak cutting force and peel cutting energy under refrigerated condition were consistently higher than that under ambient condition but the difference were statistically non-significant at $P > 0.05$ in both of the cases (Table 2).

Table 1: Rupture force, flesh firmness and total energy of guava in ambient and refrigerated conditions with respect to storage periods and maturity stages

Storage periods (days)	Maturity stage	Ambient condition			Refrigerated condition		
		Rupture force, kg	Flesh firmness, kg	Total energy, kg.s	Rupture force, kg	Flesh firmness, kg	Total energy, kg.s
1	Immature	6.82	2.66	755.46	6.82	2.66	755.46
2		3.02	1.28	353.36	5.92	1.62	496.06
3		0.71	0.48	163.54	2.20	1.28	353.36
1	Mature	3.01	0.32	102.94	3.01	0.32	102.94
2		0.75	0.15	48.47	0.85	0.24	69.07
3		0.44	0.15	45.81	0.72	0.15	48.47
1	Over mature	1.55	0.14	38.72	1.55	0.14	38.72
2		0.59	0.12	38.16	0.58	0.12	38.72
3		0.50	0.07	20.45	0.51	0.10	32.74

Table 2: Bio yield point, flesh firmness and compression energy of guava in ambient and refrigerated conditions with respect to storage periods and maturity stages

Storage periods (days)	Maturity stage	Ambient condition			Refrigerated condition		
		Bio yield point , kg	Flesh firmness, kg	compression energy , kg.s	Bio yield point, kg	Flesh firmness, kg	compression energy , kg.s
1	Immature	45.18	25.59	6283.40	45.18	25.59	6283.40
2		35.48	23.66	5300.09	41.58	25.11	5369.20
3		22.03	14.29	3024.98	30.76	21.81	4554.48
1	Mature	7.10	6.12	1373.83	7.10	6.12	1373.83
2		5.51	4.15	917.95	5.62	5.75	1099.90
3		4.32	3.71	822.47	5.35	4.10	899.22
1	Over mature	5.38	3.61	808.70	5.38	3.61	808.70
2		4.11	3.26	698.74	5.51	3.53	738.05
3		2.61	1.95	430.05	4.43	2.77	599.35

Table 3: Peak cutting force, flesh firmness and cutting energy of guava in ambient and refrigerated conditions with respect to storage periods and maturity stages

Storage periods (days)	Maturity stage	Ambient condition			Refrigerated condition		
		Peak cutting force, kg	Flesh firmness, kg	cutting energy, kg.s	Peak cutting force , kg	Flesh firmness, kg	cutting energy, kg.s
1	Immature	14.83	7.07	1861.85	14.83	7.07	1861.85
2		9.64	5.74	1382.84	11.99	6.84	1741.70
3		5.59	3.74	794.27	8.39	4.28	1001.58
1	Mature	3.82	2.79	663.14	3.82	2.79	663.14
2		2.77	1.47	392.21	2.99	1.70	427.59
3		2.29	1.18	305.68	2.37	1.31	309.94
1	Over mature	2.06	1.08	290.36	2.06	1.08	290.36
2		2.01	0.98	266.43	2.03	1.02	280.85
3		1.02	0.73	158.80	1.93	0.74	206.98

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