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Effect of Mechanical Loads on Guava Quality at Handling

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ABSTRACT

This study examined the mechanical loads of guava fruits under different loading conditions at different times. The approach will help in predicting the type and magnitude injuries, which will help in minimum losses and assessment of guava quality.It has also a significant influence on handling, sorting, storage and processing. Some physical, chemical and mechanical properties of common Egyptian guava variety (Mamora) relevant to the material handling were analyzed. The following properties were considered: dimensional size, mass, measured and calculated volumes, real density and sugar content. Mechanical tests (puncture and compression) were also considered. The rupture load, rupture deformation and the work done (energy) that caused the rupture of the fruit were determined. The maximum force and stress levels for both puncture and compression were greatest at the start of maturity stage compared with subsequent maturity stages .At any fruit position and as the stage of fruit maturity increases from start to near the final stage, a gradual decrease in the yield force and yield stress was obtained, while, the damaged area and deformation increased.During packing and handling guava and based on the above information it may be recommended, to lay the fruits on the major diameter axis position, so as it experiences less deformation under loads. It was possible to introduce a factor of safety that may be used in determining the number of fruits in a vertical load for packaging guava fruits in containers and transporting them. Based on this concept, the maximum number allowable of fruit rows inside a container should be three rows, so as to avoid bruising during fruits packaging and handling .Packing was the first step to keep the fruit quality and reduce the handling losses. Further investigations should be done to evaluate and test package type, size, and loading height during storage and transportation.

INTRODUCTION

Guava (*Psidium guajava* L.) is one of the most common fruits in the world and Egypt. The fresh fruit is very high in vitamin C and good source of vitamin A, pectin, calcium, iron, phosphorus and ascorbic acid.

The medicinal uses of guava are many and varied. Guava's can be eaten fresh, used in salads, but are often used to flavor drinks, desserts, sauces, preserves, very nice jam, jelly, ice cream, toffee and many other food products (Admin, 2014). Guava tea, the infusion of dried guava fruit and leaves, has recently become popular as a drink in Taiwan (Gupta, 2004).

Guava softens readily and therefore, has a very short shelf life, which in turn makes transportation and storage difficult (Neelima, 2011).

The total cultivated area of guava trees increased sharply through 1990-2017, from 14000 to 315281 feddans and the total production from the fruitful area was 315281 ton (Ministry of Agricultural, 2018 "in Arabic").The fresh fruits exportation has increased from 3873.7 tons in 2000 to about 9731.6 tons in 2018 (Ministry of Foreign Trade, 2018 "in Arabic").

The extent of postharvest handling losses in fruits and vegetables in developing countries reveals that in some cases losses may be as low as 5% - 25 %, whereas in others they may reach a value as high as 50% (Kader, 1992 and Hussein *et al*., 1997 "in Arabic"). In Egypt the value of postharvest handling losses in fruits and vegetables may reach 25% (Al-Giwilly, 1996"in Arabic"). Parshant *et al*. (2014) reported that the maturity index must consistently meet two requirements for all growers firstly (it should insure minimum acceptable eating quality) and secondly (a long storage life). Fruit is generally harvested when the pulp is still firm and the colour skin starts changing from dark to light green /or to a yellowish colour. Change in colour is the most apparent external symptoms of ripening in guava. Judging maturity in guava by colour is half mature (beginning maturity), full mature(medium maturity) and fully ripen (near the end maturity).

Measurements of mechanical proprieties of fruits and vegetables at different maturity stages and under different loading conditions should help in predicting the type and magnitude of mechanical injuries, which will help in minimizing losses (Peleg, 1984).

Increasing economic importance of food materials, together with complexity of modern technology for their production, handling, storage, processing, preservation, quality evaluation, distribution, marketing, and utilization demands a better knowing of the significant physico-mechanical properties of these materials. Many investigators have covered factors affecting physical and mechanical properties of fruits **.**

Mohsenin (1986), Abdel Maksoud (1992) and (Sabbah, 2002"in Arabic")) reported that the mechanical behavior could be expressed in terms of force-deformation and time; the results can lead to a rheological equation, which may predict the behavior of fruit and vegetables material under various loading conditions**.**

EI-Danasory and EI-Ebabi (1994) studied some factors affecting packing damage of different fruits (pear, apple, peach, fig, grape and.gouava).They concluded that the mean value of the compression load which cause bruise for different types of fruits was almost half of the applied load **.**

Soliman *et al*. (1994) reported that the mechanical damage of fruit during harvesting, handling, packing and transportation is related directly to the mechanical properties of the impact forces. The type and magnitude of such damages depend on the state of maturity and methods and severity of harvesting and handling **.**

The mechanical properties are considered one of the most important four parameters, which reflect the quality of food material (Bourne, 2002). These parameters include texture, firmness and chew-ability.

There are two main forces that affect tomatoes crop during their handling after harvesting operation, compression and puncture forces. Generally, the compression force is actually observed by the whole fruit and the puncture force by a specific point on the fruit. Excessive compression force results in bruising and breakage. Punctures cause in increase respiration rate, enhancing general deterioration and decreasing the visual appearance aspects (Allende *et al*., 2004). The fresh yield of any agricultural production with a high- quality as the consumers demanding increases the necessity for a reliable, rapid, nondestructive, noninvasive technique for maturity determination, especially during harvest and at the packing site (Mizrach, 2007).

The objective of the present study was to investigate some physical (dimensional, size, mass, measured volume, calculated volume, real density, sugar and moisture contents), and mechanical properties (puncture, and compression) for one common Egyptian guava variety (Mamora).

MATERIALS AND METHODS

Guava variety (Mamora) was used to evaluate their physical and mechanical characteristic. This variety is considered as exportable variety because of their good storage characteristics **.**

Experiments and Test Procedures:

The samples were picked carefully in different maturity stages. All fruits were subjected to dimensional characteristic measurements. Then the fruits were used to prepare the required specimens for physical and mechanical tests **.**

During the experiments, the following parameters were examined :

-Three stages of maturity (early stage maturity, medium stage maturity and late stage maturity).

-Three positions (major axis, major diameter, and minor diameter)

Physical Characteristics:

A random sample of 100 fruits for each maturity stage of guava variety was used. Size of each guava fruit was determined by measuring the main three dimensions of fruit to obtain; the major axis as (fruit length, L), major diameter as (fruit major diameter, D_M) and minor diameter as (fruit manor diameter, $D_m$using a digital vernier caliper with an accuracy of 0.01 mm) as shown in plate (1).

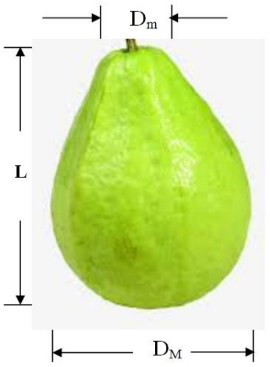

Plate 1. Main dimensions of guava fruit

The guava fruit is either rounded (i.e. globose), egg-shaped (i.e. ovoid) or pear-shaped (i.e. pyriform) and turns from green to yellowish in colour as matures (GISD, 2011).

The measurements of moisture content of guava fruits were determined based on the (ASAE standards, 1984) as follows:

Moisture content (wet basis) is determined using the convection drying oven method at 103°C for 4 hours as the average of three replicates.

Sugar content is obtained by measuring the total soluble sugar in the extracted juice by a refractometer **.**

The theoretical volumes and the real density were calculated according to (Mohsenin, 1986) and (Sitkei, 1986) as follows **:**

$$V_c = \pi (L * D_M * D_m) / 6 \quad \ldots\ldots\ldots\ldots(1)$$

$$p = M / V_m \quad \ldots\ldots\ldots\ldots(2)$$

Where: L = major fruit axis, cm .
D_M = major fruit diameter, cm .
D_m = minor fruit diameter, cm .
V_m = measured volume, cm^3 .
V_c = calculated volume, cm^3.
***p* = real density of individual fruit, g/cm^3 .**
M = mass of guava fruit, g .

The mass of each fruit was determined using an electronic digital balance having a sensitivity of 0.01g.

The obtained data of the fruit characteristics were statistically analyzed to assess the mean value, the maximum value, and coefficient of variation (C.V)

Mechanical properties :

Penetration test :

Digital penetration meter (model, Penetrometero St 308) as shown in plate(2) was used with an accuracy of 0.01 Newton, a single fruit was pressed by the conical end of the appropriate plunger with diameter 8 mm (5/16in) which is suitable for guava fruit as described by (Hussien *et al.*, 1997 "in Arabic")

Plate 2. Digital penetration meter

The digital reading was increased with the increase of the pressure on the fruit until the fruit was cracked. At this point the recorded reading (Peak) is the fruit firmness. Only one reading was recorded for each guava fruit. Measurements were taken on the three stages of maturities of fruits.

Force-deformation test:

An instrone machine model (Universal Tester-Lloyd x Instrument type LR 5KN load cell) was used for the force-deformation test, and compression - expression tests. It consists of a mechanical press, force indication system, speed controller and recording system. Both the crosshead and chart speed were 10 cm/min for all tests. The system was provided with a digital controller .

The force-deformation tests were conducted by placing the samples between two parallel plates. The sample was placed on the bottom plate while the crosshead was just touching the surface of guava at no loading. Force was applied to the fruit by the press and force transducer to the moveable crosshead . During the test, the cross head was moved down at a selected speed deforming the sample until failure was achieved. A digital screen showed the variations in force as it progressed against the sample and the peak force at which sample tissue failed was recorded.

RESULTS AND DISCUSSION

Properties:

Determinations of physical and chemical characteristics such as size, volume, etc. of guavas are very important for describing their formological characteristics in many respects and applications such as sorting, grading, and processing .

Typical mean values obtained from large number of observations for the investigated guava given are in Table (1), which shows the mathematical means of all samples, and other statistical indices for the main dimensions of the studied variety .

The data listed in Table (1) illustrate some physical properties for guava fruits under three maturity stages (half mature (beginning), full mature (medium) and fully ripen (near the end) (Parshant *et al*., 2014) It is clear that the guava variety used in this investigation is considered as pear shaped.

Table 1. Physical and chemical characteristics for three maturity stages of guava fruits.

Maturity stage	Parameters	L, mm	D_M mm	D_m mm	Mass, g	V_m, cm^3	V_c, cm^3	Real density, g/cm	Sugar brix, %	M.c% (w.b)
Beginning	Average	108.3	72.54	43.38	282.20	288.3	275.38	0.98	5.09	80.21
	Maximum	120.20	71.2	64.20	357.81	372	359.05	1.01	5.91	80.96
	Coeff. of variance (C.V %)	7.94	7.21	5.39	17.18	17.64	18.13	1.63	3.48	0.641
Medium	Average	103.5	70.29	65.81	305.89	299.6	282.89	1.02	5.82	81.6
	Maximum	120.15	63.10	72.0	380.0	380.0	359.05	1.13	6.32	82.8
	Coeff. of variance (C.V %)	7.915	8.876	8.36	12.884	14.733	15.187	4.412	2.043	0.682
Near the end	Average	108.20	76.63	6223.	327.2	316.4	298.7	1.03	6.24	83.1
	Maximum	125.5	82.90	64.9	417.1	410	387.15	1.08	7.43	84.23
	Coeff. of variance (C.V %)	8.129	6.48	6.627	17.232	18.008	18.363	1.694	4.49	1.03

It could be noticed that the real density of guava variety under study increased as the maturity stage increases from early to late stage maturity which was (0.98, 1.02 and 1.03 g/cm^3) .

Usually the densities of biological materials are affected by their chemical composition as moisture content, sugar content, etc. The average values of sugar brix, percentage, in general showed a similar trend to the values of the real density gm/cm^3, which gradually increased as maturity stage increased .

Mean while, the maturity stage has an important effect on the fruit volume, mass and density. As maturity stage increased, the volume of a specific fruit increased and its density also increased, that is due to the biochemical change during ripening which consume some of free water by plant tissues, resulting in shrinkage of fruit size more than the reduction in fruit mass, which in turn causes an increase of mass per unit volume, as shown in Table (1).

A linear correlation equation between the measured "V_m" and the calculated "V_c" volume of guava fruits at the three maturity stages for variety tested can shows in Fig. (1).

The relation form shows as follow:

$$V_m = a\ V_c$$

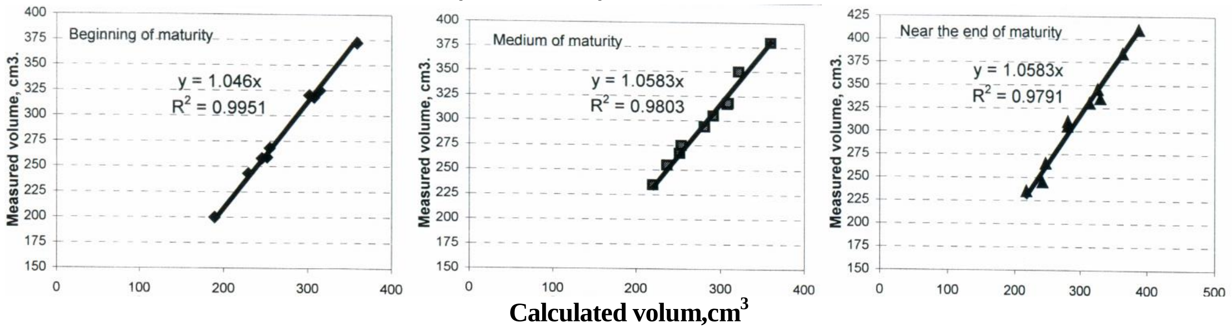

Fig. 1. The relationship between measured and calculated volume for guava fruits under three maturity stages.

From the figure it can see the strong relation which R^2 = 0.995, 0.980 and 0.979 respectively at beginning, medium and near the end maturity. These relationship could be used successfully for predicting fruit volume by knowledge of the main dimensions of fruits.

Mechanical properties :

Penetration (puncture) test :

Mechanical properties related to penetration (puncture) and compression tests are summarized in Tables (2 and 3). It can be seen that the maximum force and stress levels for both penetration (puncture) and compression varied considerably for both variety and maturity stages .

The maximum force and stress levels for either puncture or compression were greatest at beginning of maturity stage compared with other maturity stages .

This increase in the force and stress levels for puncture or compression tests may be attributed to the decrease in the moisture content and density of fruit at beginning stage than that of other maturity stages.

On the other hand, the minimum force and stress levels for either puncture or compression was found at higher maturity stage (near the end maturity) as shown in Tables (2 and 3).

Table 2. Statistical indices of penetration (puncture) tests of guava fruits at three maturity stages.

Parameters	Beginning maturity		Medium maturity		Near the end maturity	
	Skin hardness					
	Force, N	Stress MP"	Force, N	Stress	Force, N	Stress, MP"
Average	46.5	0.92	34.4	0.68	25.9	0.52
Maximum	54.8	1.09	37.8	0.78	29.9	0.89
Coeff. of variance(C.v%)	11.82	11.83	9.0	8.99	11.31	11.30

Table 3. Summary of mechanical properties of guava fruits at different maturity stage and positions.

Maturity stage	position	Compression tests								
		At yield point				At yield	At maximum point			
		Force, N	Deformation mm	Damage area, mm²	Stress, MPa	work done (Energy), Nm	Force, N	Deformation mm	Damage area, mm²	Stress, MPa
	L	65.95	3.965	69.08	0.955	0.1307	159.30	7.57	1071.53	0.149
Beginning	D	67.18	3.702	100.48	0.669	0.124	159.90	5.63	1044.05	0.154
	T	57.75	4.661	193.89	0.298	0.135	159.70	7.84	1073.88	0.149
	L	61.77	7.178	705.72	0.088	0.222	159.90	12.60	1285.83	0.124
Medium	D	61.36	5.679	489.84	0.125	0.174	159.70	11.29	1544.88	0.103
	T	57.52	8.182	439.60	0.131	0.235	123.70	10.42	1036.20	0.119
Near	L	59.13	8.869	681.38	0.087	0.262	86.47	13.16	774.010	0.112
the	D	60.72	6.988	659.40	0.0921	0.212	94.06	15.20	1444.40	0.065
end	T	53.15	9.089	660.19	0.081	0.215	114.70	15.23	1318.80	0.087

• L= Longitudinal position, D= Radial position, T = Minimum axis.

Data analysis of compression tests:

Figure (2) shows a typical force-deformation curve for a guava loaded with a plate crosshead. In the initial stages of the loading, the deformation is proportional to the applied load, as shown by line AB on the load deformation diagram. At B, the line commences to deviate from the straight, and after point B, deformation is no longer proportional to load. Point B is therefore known as the limit of direct proportionality. As the magnitude of the applied load is further increased, the material suddenly appears to be stagnant i.e., from C (yield point) to D there is a noticeable sudden increase in deformation with little or no increase in load. A bioyield point C is an indication of the initial fracture in the cell structure of the sample. After point D, the material (fruit) shows some recovery effect, and a further increase in the applied loading causes further deformation, until at point E, the maximum deformation loading is reached which causes the split to widen and broken.

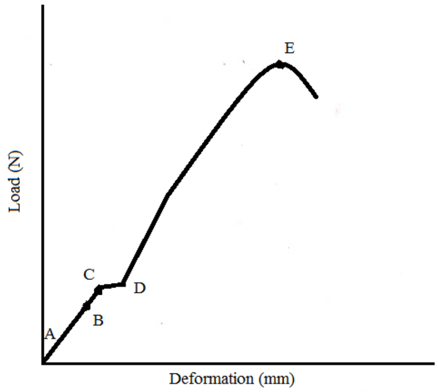

Figure 2. A typical force-deformation curve for a guava fruit.

Meanwhile, the compression tests on guava fruits indicate that the flesh was bruised just before the skin failed. However, some fruits were found to have a minor bruise without failure of the skin. In other words, the force deformation curves for guavas under certain conditions deviated from linearity depending mainly upon the cross head speed and maturity stage. Therefore, the occurrence of a bruise cannot be precisely defined from the force-deformation curve. Therefore, it was necessary to device a procedure to determine an average loading at which bruising occurs.

A number of groups of fruits were subjected to different load applications, and the area of bruising in each fruit was evaluated. Then the average compression yield force for the test was determined. By dividing this average yield force by the area, the yield stress of fruit was obtained.

Average compression yield work (energy) was determined by calculating the area under the average force-deformation curve up to the maximum yield. Data tabulated in Table (3) and Fig. (3) show the effect of different parameters (cross head load and loading position at different maturity stages) on the behavior of compression force deformation.

Generally, guava at three different positions, showed a common trend of direct proportionality and non- linear relationship between compression force and deformation. Inspection of the graphs reveals that at any fruit position and as the stage of maturity increased from beginning to near the end stage, a gradual decrease in the yield force and yield stress was obtained, while, the damaged area and deformation increased.

In other words, the best results for yield force and maximum force were always associated with lower values of deformation, resulting when loading on the major diameter of guava fruit (position, D) at beginning and medium maturity stage, which was (67.18 and 159.9 N) and (61.63 and 159.7 N.) respectively.

At any loading position of guava fruits, and as maturity stage increase from beginning to near the end stage, the yield force (N) and stress (MPa) gradually decreased meanwhile, the damaged area (rnrn^2) and deformation (mm) were always increased. The values of rupture deformation and the rupture energy, in general showed a similar trend to the values of rupture force for guava, as shown in Table (3).

The maximum rupture force values for the beginning maturity stage averaged from 159.3 to 159.9 N. On the other hand, the maximum rupture force of beginning maturity was larger than that of near the end maturity by about 1.84, 1.7 and 1.39 times, when loading position was done on the major axis, major diameter and minor diameter (positions L, D_M and D_m), respectively.

The values of rupture energy (work done) of guava fruit ranged from (0.124 to 0.135 Nm), (0.174 to 0.235 Nm), and (0.212 to 0.262 Nm) at beginning, medium, and near the end maturity stage, respectively.

During packing guava fruits at beginning and medium maturity stages, and based on the above information it may be recommended, to lay the fruits on the major diameter axis, so as it experiences less deformation under different loads. In addition, it may be possible to develop good quality in terms of mechanical properties.

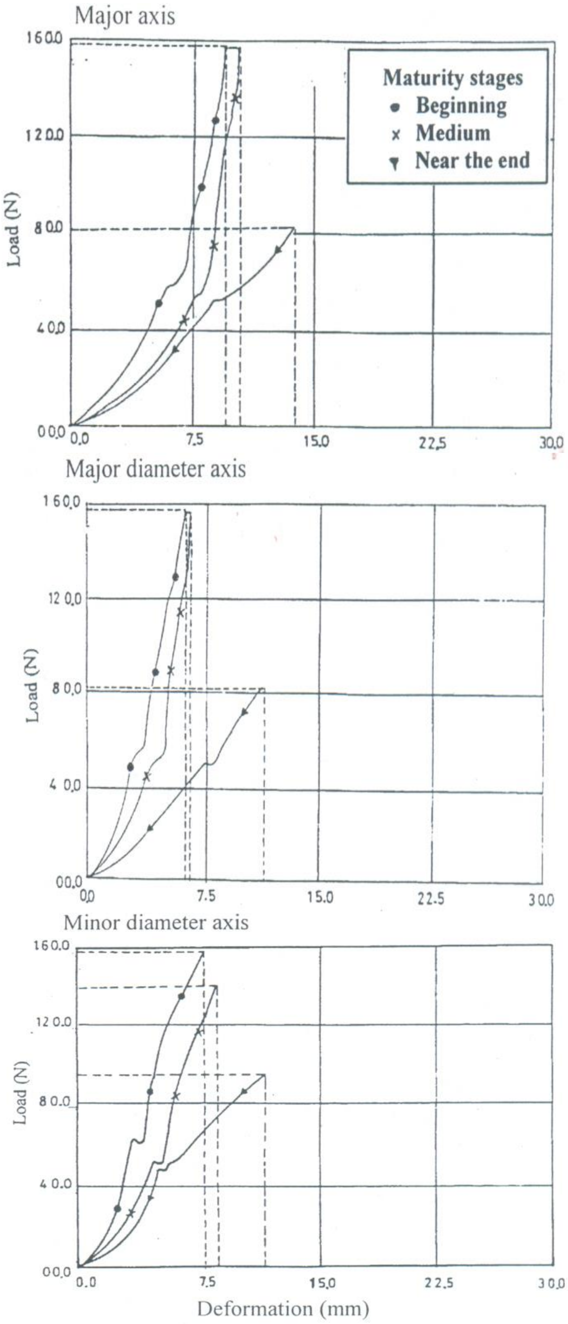

Fig. 3. The relationship between the compressive force (Load, N) and deformation (mm) under three maturity stages and three positions of guava.

In Egypt, most fruits are handled in containers made of hard paper, plastic and /or palm tree branches, generally in almost similar sizes for different types of fruits, thereby a large quantity of fruits are subjected to damage. Highest priority should be given to decrease the handling damage through modifying and improving the protective packaging of the fresh fruits. Therefore, the allowable compression loads on the fruits, which are always associated with the number of rows of fruits inside the container, must be taken into consideration.

The deformations caused by stacking the agricultural materials are partly elastic and partly plastic. The degree of elasticity of a material is characterized by the ratio of the elastic and the total deformations (sum of the elastic and plastic deformations). The plastic deformation is due primarily to the presence of pores, macroscopic cracks and discontinuities in the texture and fruit skin. Consequently, it would be foolish to increase the compression loads (due to number of rows inside the container), to approach the yield stress or the point where permanent deformation may take place.

A factor of safety (*F.s*) may therefore, be devised or introduced and proposed to be:

$$F.s = \frac{\text{stress at yield point, (MPa)}}{\text{Stress at maximum point, (MPa)}}$$

That may be used in the design calculations of fruit containers. The factor is in reality a margin of safety. Its value can range from1.5 to 10, depending on properties of the specific materials (fruits) being used (Creamer, 1984). As a matter of fact, it may also take into consideration the strength of container material as well.

Under the present study, the factor of safety was calculated at highest maturity stage (beginning)and position (L), according to the aforementioned definition of the factor of safety (F.s) for guava = (0.955/0.149) which was 6.41.

Therefore, it may be recommended that the maximum number allowable of fruits rows inside a container should be three rows for guava fruits, so as to avoid bruising during fruits packaging and handling.

Packing was the first step to keep the fruit quality and reduce the handling losses. Further investigations should be done to evaluate and test package type,size, and loading height during storage and transportation should be made in the future.

CONCLUSION

The data indicated that as maturity stage increased, the volume and the density of the specific fruit increased.

The maximum force and stress levels for both puncture and compression were greatest for guava fruits and at beginning maturity stage compared with other maturity stages.

At any fruit position and as the stage of fruit maturity increased from beginning to near the end stage, a gradual decrease in the yield force and yield stress was obtained, while, the damaged area and deformation increased.

The maximum rupture force at the beginning maturity was larger than that of near the end maturity by about 1.84, 1.7 and 1.39 times for guava fruits, when loading position was done on the major axis, major diameter and minor diameter (positions L, D and T), respectively.

It may be recommended, to lay the fruits on the major diameter axis position during packing guava fruits, so as it experiences less deformation under loads. Also, the maximum number allowable of fruits rows inside a container should be three rows for guava, so as to avoid bruising during fruits packaging and handling.

Packing was the first step to keep the fruit quality and reduce the handling losses. Further investigations should be done to evaluate and test package type, size, and loading height during storage and transportation should be made in the future.

REFERENCES

Abdel Maksoud, M.A., 1992. Rheolgoical properties of tomato and their dependance on maturity.M.Sc. Thesis Agr.Eng. Dep, Fac. of Agr.,Alex. Univ.

Admin, M. E., 2014. Guava – postharvest and processed products. International tropical fruits network.

Allende,A., Desme, M., Vanstreels, E., Verlinden, B. E. and Nicolai, B. M., 2004. " Micromechanical and geometrical properties of tomato skin related to differences in puncture injury susceptibility ". Post-harvest Biology and Technolog. 34 (2) : 131-141.

ASAE, 1984.Compression tests of food materials. ASAE standards 1984.ASAE.St Joseph, MI 49085.

Bourne, M., 2002. " Food Texture and Viscosity "2nd ed. Academic Press.

EI-Danasory, M. M. and F.G. EI - Ebabi,1994. Study of same factors affecting packing damage of different types of fruits,. Misr. J. Eng.11 (2):312:322.

GISD,2011.Global Invasive Species Database online data sheet. Psidium guajava (tree, shrub). www.issg.org/ database. Accessed March 2011.

Gupta, S., Kataria, M., Gupta, P. K., Murganandan, S., and Yashroy, R., 2004. Protective role of extracts of neem seeds in diabetes caused by streptozotocin in rats. Journal of Ethnopharmacology, 90, 185–189.

Kader, A.A. 1992. Postharvest technology of horticultural crops. Publication3311 University of California, Division of agriculture and natural resources, Davis, CALIF **.**

Mizrach, A., 2007. Nondestructive ultrasonic monitoring of tomato quality during shelf- life storage. Post-harvest Biology and Technolog. 46 (3) : 271-274.

Mohsenin, N. N. 1986. Physical properties of plant and animal materials, Gordon and Broach Science. Publishers. Inc., New York**.**

Neelima Garg. 2011. Postharvest management and value addition of guava.neelimagargg @ rediffmail.com.

Parshant,B. ; V. K. Wali ;A. Sharama ; G. Kour and D. Bhat (2014). Maturity indices of guava. Divion of fruit science, SKUAST-J.

Peleg, K.1984. A mathematical model of produce damage mechanisms**.** Transactions of the ASAE 27(1): 287-293.

Sitkei, G. 1986. Mechanics of agricultural materials. Amsterdam, Oxford, New York, Tokyo**.**

Soliman, S.N.; M.A. Sabbah and M.A. Abdel Maksoud.1994. Dynamic force deformation tests of tomatoes and their dependence on maturity. Misr. J. Eng.11 (2): 391-404.

الجويلي, أ. أ.(1996). " ندوة عن أسباب فجوة الغذاء في مصر" – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة.

الشريف, ع. ح., فاطمة خليل.أ., مرادم. ي., قرشي, م. ع., (2011). زراعة وأنتاج الجوافة. نشرة فنية – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة.

الصباح ،م. أ. (2002). التقرير الفني النهائي للمشروع البحثي دراسة الخواص والخصائص الطبيعية لبعض المحاصيل الزراعية للأستفادة منها في تصميم وتطوير نظم ومعدات الحصاد الميكانيكي والتداول – أكاديمية البحث العلمي والتكنولوجيا – يونيو 2002.

حسين, ع. ، قمرة ، ع. ، بهجت, م. (1997). الجودة والأمان في محاصيل الخضر والفاكهة للتصدير – الدورة التدريبية في مجال تكنولوجيا تداول الحاصلات البستانية بعد الحصاد. (التوصيات للمحافظة علي مواصفات الجودة بعد الحصاد).مشروع استخدام ونقل التكنولوجيا الزراعية ATUT.

وزارة التجارة الخارجية ، (2018). الدليل الأحصائي لتسويق المحاصيل الزراعية في مصر –قسم بحوث التسويق – معهد بحوث الأقتصاد الزراعي - مركز البحوث الزراعية.

وزارة الزراعة واستصلاح الأراضي، (2018). الإحصاءات الزراعية.

تأثير الأحمال الميكانيكية علي جودة ثمار الجوافة أثناء التداول

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تعتبر الجوافة واحدة من أكثر ثمار الفاكهة المفضلة في مصر والدول العربية بل وفي جميع دول العالم لما لها من مذاق مستحب ونكهه مميزة ويمكن تناول ثمارها طازجة أو كسلاطه، مربي، عصير، جيلي، حلوي وغيرها. وكذلك يمكن أستخدام أوراقها كشاي طبي. وثمار الجوافة غنية جدا بفيتامين (ج) أغني من الموالح ومصدر لفيتامين (أ) والبكتين والكالسيوم والحديد والفسفور وغيره (الشريف وآخرون, 2011 "عربى"). وقد زادت المساحة المنزرعة من 14000 الي 41889 فدان من عام 1990 حتي عام 2017 ليصل الإنتاج الي 315281 طن ويتراوح محصول الشجرة البالغة البكرية حوالي 30 - 50 كجم و قد يصل الي 70 كجم للأشجار المعتني بخدمتها وتربيتها (وزارة الزراعة, 2018"عربى"). كما زادت الكميات المصدرة من ثمارها الطازجة من 3873,7 الي 9731,6 طن منذ عام 2000 حتي عام 2017وذلك لزيادة الطلب عليها بالأسواق العالمية (وزارة التجارة الخارجية, 2018 "عربى"). ونظرا لهذه الأهمية فقد تم دراسة تأثير الأحمال الميكانيكية علي ثمار الجوافة اثناء عمليات التداول مما ينتج عنه ثقب أو شق أو تلف في الثمار مما يعرضها للأصابة الحشرية أو البيولوجية أو الفساد مما يؤثر علي جودة المنتج وقيمته السعرية. وتقدر نسبة الفقد النوعي و الكمي في الثمار الطازجة خلال تداولها من المزرعة حتي المستهلك من 5 – 25 % في الدول المتقدمة بينما تصل الي 50 % في الدول النامية (حسين وآخرون ،1997"عربى"). وتصل نسبة الفاقد من الفاكهة والخضر في مصر الي 25 % وتقدر بحوالي 13 مليار جنيه سنويا (الجويلي, 1996"عربى"). وقد تم إختيار صنف معمورة عالي الجودة من أصناف الجوافة الشائعة في مصر ذو قيمة تصديرية عالية ويتميز بزيادة الإنتاجية. ويهدف البحث إلي دراسة تأثير الأحمال الميكانيكية علي تلف ثمار الجوافة أثناء التداول مما يساعد على تقليل نسبة الفاقد والتالف من الثمار خلال مراحل التداول المختلفة وذلك لتحديد أقصي عدد من الثمار يمكن أن تتحملها الثمرة فوقها دون حدوث تلف وكذلك أنسب وضع للثمرة داخل العبوة. وقد تم دراسة بعض الخصائص الطبيعية والكيميائية للثمار (أبعاد الثمرة – الحجم – الكتلة – الكثافة – المحتوي الرطوبي – تركيز السكر- تركيز المواد الصلبة الكلية بالثمار) خلال ثلاثة أطوار نضج مختلفة.و أجريت بعض الإختبارات الميكانيكية علي الثمار مثل اختبار الثقب (قوة اختراق الثمار), و اختبار الضغط علي الثمار لدراسة العلاقة بين القوة والانضغاط لأطوار النضج وأوضاع التحميل (باتجاه المحور الطولي (L), القطر الأكبر(D_M), القطر الأصغر (D_m) للثمرة) مع حساب قوي وطاقة التحميل والشغل المبذول علي الثمار ومسافة التشوه ومساحة التلف. وكذلك تحديد نقطة الخضوع الحيوية والنقطة القصوي ونقطة التصدع الظاهرية. وأوضحت النتائج أن شكل ثمارالجوافة لهذا الصنف يميل الي الشكل الكمثري و أنه بزيادة طور النضج يزيد حجم ثمار الجوافة وكتلتها وبالتالي تزيد كثافة الثمار ويزيد تركيز السكر.وكذلك يزيد التشوه في الثمارعند التحميل علي أي وضع من الأوضاع الثلاثة بزيادة طور النضج وكانت أكثر التشوهات عند إختبار تحميل الثمار علي المحور الطولي (الوضع L) بينما كانت أقل التشوهات عند إختبار تحميلها علي القطر الأكبر (الوضع D). وتعتبر التعبئة الصحيحة هي أول خطوة للمحافظة علي جودة الثمار ولتقليل فواقد التداول. لذلك توصي الدراسة بتعبئة الثمار ووضعها داخل العبوة علي القطر الأكبر(D) وذلك لانخفاض قيمة التشوهات الناتجة عند تحميلها علي هذا الوضع, وآلا يزيد عدد الصفوف للثمار فوق بعضها داخل العبوة عن ثلاثة صفوف.