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Physical and Mechanical Properties of Peach

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Abstract: Knowing physical and mechanical properties of peach could be useful not only in design of equipment for harvesting and processing but also to establish information database of this fruit. In this research some properties of peach, Tabrizi variety, were investigated. The mean of physical properties including mass, volume, dimensions (big, medium and small diameters), arithmetic mean diameter, sphericity and density were found to be 137.37 g, 107.37 cm^3, 61.1 mm, 60.29 mm, 59.21 mm, 60.14 mm, 96.05% and 1.24 g/cm^3, respectively. The mean of mechanical properties including stiffness of peach, without and with peel, were 11.35 and 15.31 N, respectively. The linear relationship was found between mass and volume, mass and three orthogonal diameters, volume and three orthogonal diameters, stiffness without peel and geometric mean diameter, also stiffness with peel and geometric mean diameter with correlation coefficients of 0.625, 0.743, 0.63, 0.872 and 0.897, respectively.

Key words: Peach · Properties · Stiffness · Sphericity · Density

INTRODUCTION

The annual production of peach in the world is estimated around 11 tones which Iran with 267000 tones takes 9th place among producing countries [1]. Increasing demand of consumers for fresh fruits and vegetables with high quality has encouraged farmers and distributers to increase their attempts for providing high quality of produce. The quality of produce is affected by sensational characteristics (appearance, texture, taste and aroma), feeding value and chemical combinations which each has made an extend subject for continues research [2]. Determination and application of physical and mechanical properties of fruits and vegetables in design and fabrication of processing equipment such as sorters can significantly improve the results of sorting and grading of produce. Using non destructive methods for quality evaluation of agricultural produce is a good example of applicability of such studies.

There are various methods to measure the properties of agricultural produce. Machine vision, ultrasonic and image processing are good examples of the applied latest technology for this purpose. Compression test is one of the main and common applied methods to determine mechanical properties of fruits and vegetables. Many researchers used this method to study the mechanical behavior of various produce in different cases including peel, flesh and unpeeled sample [3-14]. Tensile test is also applicable for this purpose but it is not as common as compression test. The difficulty in the holding of skin specimens during the test and creation of premature tensile failure during specimen preparation are some examples of limitations for conducting tensile test. On the basis of the results of compression tests which have been carried out on peach, it can be graded as mature fruit when its resistance to rupture reaches to either 15 (peeled peach) or 10 N (MT method using 8 mm diameter of indentor) [9, 7].

The attempts to find any published work about the physical and mechanical properties of different varieties of peach led to only one documented research on saffron variety of Iranian peach [15]. The possibility of existing relations among different parameters of this variety was investigated. They revealed that the correlation coefficient between mass and volume, mass and cross diameters and volume and cross diameters are higher than 90%. They investigated mechanical behavior using parallel plates in compression test. The rupture energy and tangential elasticity modulus of this variety were also reported as 2.06 ±1.82 mJ (for 5 mm deformation) and 1.53 ± 0.06 MPas, respectively. The resistance of this variety to penetration of a steel indentor was reported equal to 1.46 MPas in 27.3 mm depth of deformation.

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In this research, some applicable physical and mechanical properties of Tabrizi variety of peach, as one of the most common Iranian varieties, in design and fabrication of processing equipment were investigated. The relationship among the studied parameters is also examined.

MATERIALS AND METHODS

To conduct the planned experiments, 60 fresh peaches, Tabrizi variety, were randomly selected from different local orchards around Tabriz, Iran. The peaches were ripe, defect-free and in different sizes. They were prepared for tests by keeping them under controlled laboratory conditions at least 24 hours prior to tests. The applied method of measurement is explained as below.

Measurement of Physical Properties: Three orthogonal diameters of peach (Fig. 1) was measured using vernier caliper (Shoka Galf, China) with accuracy of ±0.01 mm. A digital scale (GF 6000, A&D, UK) with accuracy of ±0,01 g was used to measure the mass of samples. The mean of arithmetic diameter (mm) was calculated as the third radical of multiplied three diameters. The sphericity was calculated with dividing the mean of arithmetic diameter to the biggest diameter multiplied 100. The floating method applied to measure density of selected peach samples. Toluene was used for this purpose.

Measurement of Mechanical Properties: The ASAE standard [16] was applied to conduct compression test. Universal Testing Machine (UTM) manufactured by Sanje Sazan e Shargh, Iran. The prob tip geometry especially size and shape must be carefully considered in any compression test because the results obtained from compression test are affected by its geometry and dimensions. The attempts have been made to standardize above parameters as well as other test conditions such as crosshead speed. Thus a cylindrical probe of spherical end (8 mm diameter) was used. The speed of loading was equal to 0.5 mm/s for all experiments. Every whole peach as a sample was loaded from both sides (direction b, Fig. 1). One side was not peeled and tested as an unpeeled case but the other side was gently peeled (equal to the diameter size of probe) and tested as a peeled case. To minimize the error of obtained data during loading samples, a bed of soft sea sand was used to place the whole sample on it. The results of experiments in the form of force-deformation curves saved in the format of Excel file on attached computer. Excell software (2003) was used for analyzing the obtained data.

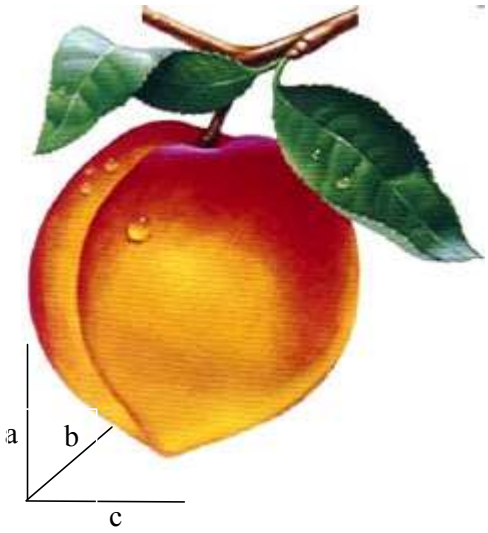

Fig. 1: Three orthogonal directions of peach

The maximum necessary force to rupture peeled and unpeeled peach is reported as stiffness without and with peel. The maturity of samples was evaluated by a panel of five persons in two categories named matured and less matured.

RESULTS AND DISCUSSION

The obtained results of the determined physical and mechanical properties of peach, Tabrizi variety and their analysis are shown in Tables 1, 2. The high standard deviation value of mass (25.45) clears good selection of samples from a wide range of dimensions and volumes. Despite high standard deviation value of mass, the appearance of this variety of peach was very close to sphere because of high value of sphericity and almost low standard deviation. Almost high standard deviation value of density (0.17) indicates the variety of density which may attributes to the different levels of maturity of sample fruits.

There was a significant difference between the stiffness of peeled and unpeeled peaches both matured and less matured fruits. It attributes to the significant effect of peel on stiffness of peach regardless of the level of its maturity. General comparison of obtained data for matured and less matured peaches shows the less matured peaches had much higher value of stiffness compared with matured ones. It indicates that the role of texture of peach in the total value of stiffness is significant. It can be also concluded that the contribution (%) of peel to total stiffness of peach for matured and less matured fruits remains almost constant (66%). Therefore, the progress in the maturity of peach influences only the texture of peach.

Table 1: The analysis of the studied physical properties of peach

Property	Minimum	Maximum	Mean	Standard deviation
Mass (g)	5.86	5.181	37.137	45.25
Diameter a (mm)	8.47	1.730	1.610	83.40
Diameter b (mm)	1.43	6.690	29.600	731.50
Diameter c (mm)	6.42	6.700	21.590	417.50
Arithmetic mean diameter (mm)	44.44	85.680	14.600	785.40
Sphericity (%)	6.82	74.990	05.960	6.30
Density (g/cm^3)	889.00	73.100	245.100	173.00

Table 2: The analysis of the studied mechanical properties of peach

Stiffness (N)	Maturity level	Minimum	Maximum	Mean	Standard deviation
Peeled peach	Matured	0.55	70.33	97.12	25.11
	Less matured	58.20	20.41	17.78	46.11
Unpeeled peach	Matured	54.21	63.57	83.38	17.12
	Less matured	59.21	94.74	58.53	45.18

Table 3: Regression equations obtained for physical properties

Correlation coefficient	Standard error	Linear regression
0.625	0.79	M= 71.57+0.613V
0.743	13.25	M= -146.832+1.724a+0.946b+2.034c
0.63	20.50	V= -233.401+2.771a+0.365b+3.198c

M: mass; V: volume; a, b and c: diameters

Table 4: Regression equations obtained for arithmetic mean diameter and stiffness

Correlation coefficient	Standard error	Linear regression
0.872	0.59	D_a=0.416 S_p + 61.45
0.897	1.38	D_a=0.29 S_u +54.11

D_a: arithmetic mean diameter; S_p: peeled stiffness; S_u: unpeeled stiffness

The results of examined relationships among the studied properties are shown in Tables 3, 4. There was a linear relation between mass and volume. It indicates that the volume of this variety of peach can be almost accurately estimated using its dimensions (diameters). A good linear relation (Table 4) was also found between the arithmetic mean diameter and the value of stiffness (with and without peel). It indicates that the stiffness of this variety of peach can be estimated using the mean value of arithmetic diameter without conducting a destructive compression test.

CONCLUSIONS

Some physical and mechanical properties of peach, Tabrizi variety, was investigated. Mass, volume, diameters, arithmetic mean diameter, density and sphericity as physical properties and stiffness of peach (with and without peel) as mechanical properties of fresh peach were determined. Good linear relationships were found between the investigated physical and mechanical properties of this variety of peach. The results showed that indicating of the value of stiffness without using destructive test is easily possible using the arithmetic mean diameter.

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