J. Appl. Environ. Biol. Sci., 4(11S)1-5, 2015

ISSN: 2090-4274
Journal of Applied Environmental and Biological Sciences
www.textroad.com

Determining the Fatigue Level of the Apple (*Yellow DeliciousVar.*) in a Fall from a Height onto the Surface of Various Materials using Image Processing

Mohsen Azadbakht[1*], Hajar Aghili[1], Ali Asghari[1], Ali Kiapey[2]

[1]Department of Bio-System Mechanical Engineering, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran.
[2]Department of Agricultural Machinery, Faculty of Bio-System Engineering, University, College of Agriculture and Natural Resources, University of Tehran, Karaj, Iran.

Received: October 29, 2014
Accepted: December 31, 2014

ABSTRACT

Apple is a kind of fruit which from harvest to delivery to the customer is placed under various loads. Bruise in various stages of displacement, transportation, packaging occurs due to brunt. In this study some of the factors affecting levels of apple bruise including drop height, material and level of storage at room temperature were investigated. The impact of these factors on apple bruise using a completely randomized design with factorial experiment with three levels of drop height for 0.5, 1, 1.5 m, three level of wood, plastic, soil with thickness 9 mm and treated in triplicate with sets of 27 repetitions of each, were analyzed. The results showed the effect of surface height and gender on bruise level in 1% is meaningful ($p<0.01$)but the storage effect is not meaningful. By reducing heights, the bruise levels will be reduced. In height of 45cm bruise level will be$456.42mm^2$ and in height of 15cm the bruise level will be$159.63mm^2$. It was also observed that with change of bruise surface from soil to wood crush level will be changed from $3.3mm^2$ to $7.3mm^2$.

KEYWORDS: Fall Height, Bruise Surface, Material, Apple, Mechanical Damage

1. INTRODUCTION

Apple is a horticulture crops that is widely cultivated in Iran. Obviously, when the fruit is harvested, it can be consumed fresh and should not be processed with different methods [4]. One of the main factors affecting post-harvest losses of agricultural products is mechanical blows. Annually high percentages of these products due to the same cause or exacerbate are lost or have reduced quality. Today, due to the growing need to protect the public health, the use of fresh fruit with good quality, seems necessary. On the other hand, annually a high percentage of fruit crops are lost due to mechanical damage or reduced quality. The reduction in quality will result in reduced production in the marketplace which can be compensated by preventing this type of damage through better understanding of the factors and circumstances. Also amount and existence of a bruise has the key role in the separation stage of healthy products and grading[8].

Frequently bruises during picking, handling, packaging, grading, warehousing and transportation will occur due to trauma. Mechanical damages as the main factor in post-harvest losses havebeen known to reach the consumer products [17]. During harvest, the dynamical time of the creation of a bruise on products, is more effective, because of the dynamic load in terms of value are more effective than static loads[9,10]. Although the mortality rate is usually between 10 to 25 percent[14], but in some apple varieties, compared to 50 percent reported in the various reports[12].It has been reported very differently for example the fatigue level of Apple in the boxes during transportation from gardens is 15 to 47.5 percent and for U.S. Extra Fancy classification it is mentioned from 67.5 to 92.5 [16]. In one particular study, filling boxes without cushion material causes 89 percent fatigue in fruits and Michigan scientists believe that 35 percent of bruises occurs during harvest and transportation [9]. In recent years, several studies in the field of traumatic injuries to the fruits and the tests were performed[3,13,17,18]. Fall heights and gender effects on the level of persimmon was researched and it was concluded that by changing height and surface material, the level of fatigue will change. Thus the increase in height from 15 to 30 and 45 as well as the changes made to the surface of contact from plastic to wood and steel increased level of fatigue is observed[2]. Some of the factors affecting the rate and volume of apple fatigue cultivar 'Golden Delicious' include the fall height, surface type and speed linear motion on the conveyor belt were observed. Experimental results showed that the fall

***Corresponding Author:** Mohsen Azadbakht, Department of Bio-System Mechanical Engineering, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran. Email: azadbakht@gau.ac.ir ,

height and impact of contact surface material on fatigue area was significant at the 1% levels meaningful, while fatigue volume was only affected by the type of contact surface material. In a research amount of resulted damage came to fresh tomato is studied with determining the effect of fall, gender, and level of maturity and fruit size effects on crop damage and it was found that most of the damage caused by the impact is the result of fall on the metal surface and the energy of the drop height and fruit mass is affected [7]. Some mechanical properties of tomato fruit on the shock loading test, effect of fall height also cultivators and post-harvest time on how fragmented mechanically wastes were examined during three days of storage and fall height and time of harvest on the variables of mechanical failure and waste of pounded fruits are not meaningfully and significantly disrupted[10].Research on physical and mechanical properties of persimmon that is needed to reap the equipment design, processing and transportation, sorting and packaging were measured[6].The physical and mechanical properties of Fuyu persimmons were measured[1]. Some physicochemical and hydrodynamic properties of two varieties of persimmon Diospyros kaki Diospyros virginiana was examined[5].Determining physical properties of agricultural products is a base for designing and building machines of harvesting, packing and processing of agricultural crops. Studying behavior in effect of falling from a height and hitting with different surfaces has special importance because of reducing mechanical damages to crops during harvest and after harvest phases. Because of this, this paper was studied physical properties and the bruise resulting from fall of apple on different surfaces.

2. MATERIALANDMETHODS

Yellow delicious apple was prepared from the garden in Tehran. The initial moisture content by drying in an oven at a temperature of75±5 earned the equivalent of 77.63 (w.b.%).The mass of the samples was measured by a digital scale, with accuracy of 0.01 g samples were divided into three weight categories. Repetition of the test for each treatment of each test sample was selected from each class.

2.1 Machine Vision System

The system consists of two parts: hardware and software. The hardware of computers, cameras and imaging chamber is formed. The camera was connected by cable to a computer and the images were stored on a computer's permanent memory. Used computers running windows seven, five-core central processing unit and RAM was 4 Gigabytes. Computer is the processing of the data and the image acquisition step to the final step, the output data is the most important role. The used camera was a Canon that was made in Japan it was mounted vertically inside the box. Shooting box was used just because all the photos must be taken in a constant condition of light regarding light intensity of surroundings and distance of apples from the camera. Chamber made of wood and shaped like a cube with dimensions of 45 × 45 × 45 cm, which is just an open area, was built. Three eight W fluorescent lamps for lighting inside the box to the ceiling box around the triangle mounted camera was used. Image J analyzer is a powerful software and have various uses. This software can calculate area and pixel value statistics of user-selected portions of the image.

2.2 Testing Method

Tests were done on three levels of storage, three hits and three heights and three replications(totally 81 samples). The first storage level, after the apples being picked from the garden, the second level after maintenance in stocks for seven days at room temperature and this third level were done in the same stock with the same temperature after 14 days. To measure the mass, precision digital scale was used with accuracy of 0.01 g, a long ruler was used to determine three heights of 0.5, 1, 1.5 m, digital camera for taking pictures were used and to calculate the area of contusion image processing software (Image J) was used. To throw apples, three levels of wood, soil and plastic with a thickness of 9 mm was used. To calculate the moisture content of each apple the formula (1) was used[11]:

$$\%w.b = \frac{m_1 - m_2}{m_1} \times 100 \qquad (1)$$

m_1 : Apple initial mass (mass before drying)

m_2: Apple Secondary mass (mass after drying)

w.b.% : percent of moisture content of wet-base

To investigate the effects of gender, height and surface on apple rots similar figure (1) was used. According to model shown on tip heights of 0.5, 1 and 1.5m and three levels of plastic and soil with thickness of 9 mm was coupled and apple fruit was released from mentioned height vertically through different levels.

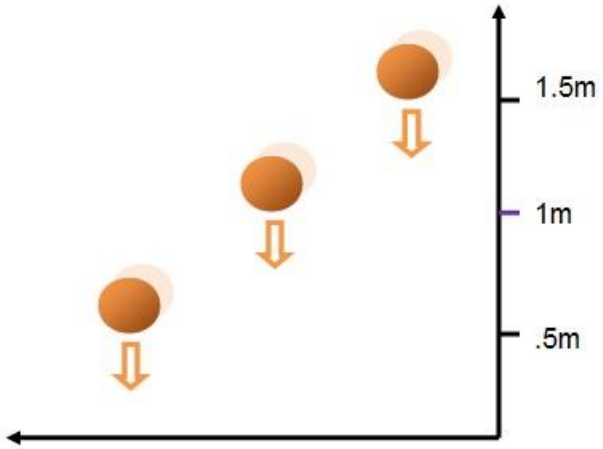

Figure 1. Schematic of the falling apple, horizontal surface represents the surface of the soil, wood and plastic, and the vertical is the height of fall 0.5, 1and1.5m.

Then to determine the damaged parts of the sample a soft marker was used to draw a line slowly around the damaged area. After lining apple photos were taken with a digital camera from the damaged area so that the angle of the photo with that surface is 90°. It is done a photograph room which viewpoints and camera angles and also lighting and distance from the lens can be adjusted and the obtained results are used to determine the desired surface area by image processing software.

3. RESULTS AND DISCUSSIONS

Analysis of variance of the Interior, together with the height of the fall and the level of interactions on the surface of the apple bruise in table 1 is given. Height and gender influence on the level of fatigue is significant at the 1% level ($p < 0.01$). But the warehousing effect was not meaningful. Figure 2 shows the changes in the level of fatigue by changing the height, between the height of the fall of fatigue at different levels (three heights of 0.5, 1, 1.5 m) there is a meaningful difference. As can be seen by reducing the height, the fatigue level will be reduced. The reason is that, damage to apple at low height is less and at high height damage to apple is greater. In 1.5m height the fatigue level is 7.55 mm^2 and in 0.5m it is 3.60mm^2.This results are the same as the ones obtained by Tabatabai Kaloor and et al. (2011) [15]and also Azadbakht and et al. (2014) [2] stated that reduction of the height of the fall of an apple and persimmon will reduce fatigue level. Also, as shown in figure 3 it was observed that with the change of surface contact of the soil to the wood bruises from 3.3 mm^2 to 7.3 mm^2. The reason is that, collision of two soft body (apple and contact surface) leading to less damage to apple, whereas the collision of apple with rigid body, leading to high damage. The results are similar to the results Lewis et al.,(2007) and Azadbakht and et al. (2014) the reported use of cardboard and wood instead of steel in contact surface the fatigue levels are decreased to 26 and 7%. Therefore, according to the results, the height of 0.5 m and the soil surface leading to minimum damage to apple and wood surface at height of 1.5 m leading to maximum damage.

Table 1. Analysis of variance of the main factors and their interactions on the surface of the Yellow delicious apple bruise

Items	Degree of freedom	Sum of squares	Mean square	F
Contact surface material	2	230.74	115.37	40.33**
Height	2	210.24	105.12	36.75**
Storage	2	4.70	2.35	0.82 ^{ns}
Contact surface material ×Height	4	0.26	0.06	0.02 ^{ns}
Height × Storage	4	10.77	2.69	0.94 ^{ns}
Contact surface material × Storage	4	17.94	4.48	1.57 ^{ns}
Error	62	177.37	2.86	

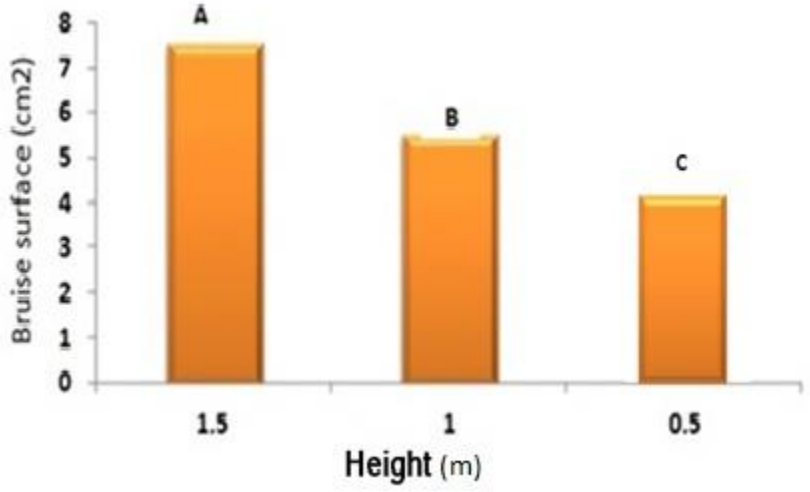

Figure 2. The effect of height on area of contusion

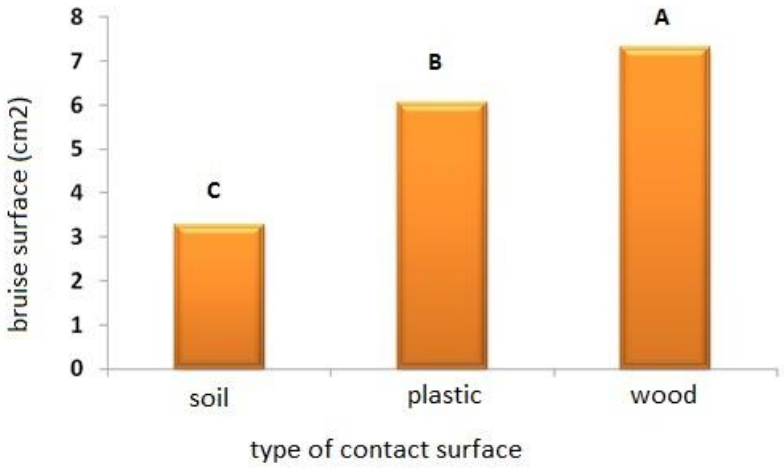

Figure 3. The effect of gender on the surface area of contusion

REFERENCES

[1] Altuntas A., Cangi R., Kaya C. 2010. Physical and chemical properties of persimmon fruit. International Agrophysics 25, 89-92.

[2] Azadbakht, M.,Tajari, N.,Kiapey,A., Alimohammadzadeh,S.2014. Effect of Fall Height and Impact Surface Material on the Bruise Surface of Persimmon (Fuyo Var). International Journal of Biosciences4(2): 254–259.

[3] Bajema, R.W., Hyde, G.M.1998. Instrumented pendulum for impact characterization of whole fruit andvegetable specimens. Trans. ASAE 41(5): 1399–1405.

[4] Beiragi T., Sh Emadi,B , A qualitative and quantitative effects of the ultrasound wave to sliced drying apple .5th National Congress of Agricultural Machinery Engineering and Mechanization, Mashhad, Iran.

[5] Hasanpour Kahnamuyi H., GHaffari H,, Marghoub N., Alipasandi A. 2013. Study of some physical, chemical and hydrodynamic properties of two varieties persimmon in ripening. International Journal of Agriculture and Crop Sciences. IJACS5(13), 1418-1423

[6] Hazbavi E., Minaei S., Ghobadian B., Kazemi SH. 2008. Persimmon fruit behavior under load. 5th National Congress of Agricultural Machinery Engineering and Mechanization, Mashhad, Iran.

[7] Idah P.A., Ajisegiri E.S.A, Yisa M.G. 2007. An Assessment of Impact Damage to Fresh Tomato Fruits. AU J.T 10, 271-275 .

[8] Kafashan,J., Sadrnia,H., Ramon,H. and Tiskinz, R.The dynamic properties of fruit in the test .5th National Congress of Agricultural Machinery Engineering and Mechanization, Mashhad, Iran.

[9] Kupferman, E. 2006. Minimizing bruising in apples, Postharvest Information Network, Washington StateUniversity, Tree Fruit Research and Extension Center.

[10] Mohammadi Ailar S.A., Minaie S., Afkari sayyah A.H. 2010. Investigation of the mechanical properties of tomatoes under compressive loading during post-harvest ripening. Sixth National Conference on Agricultural Machinery Engineering and Mechanization, Tehran University, Tehran, Iran.

[11] Mohsenin, N.N. 1986. Physical properties of plant and animal materials. Gordon and Breach sciencepublishers,New York, 498

[12]Pang D. W., Studman C. J., Ward G. T. 1992. Bruising damage in apple-to-apple impact . Journal ofAgricultural Engineering Research, 52 (4): 229 – 240.

[13] Schulte-Pason, N.L., Brown, G.K., Timm, E.J. 1992. Apple impact damage thresholds.Appliedengineering in agriculture, 8 (1), 55-60.

[14] Studman C.J., Brown G.K., Timm E.J., Schulte N.L., Vreede M.J. 1997. Bruising on blush and nonblushsides in apple-to-apple impacts. Transactions of the ASAE, 40(6): 1655-1663.

[15] Tabatabaekoloor R., Kolouri A., Hashemi S.J., Hadipour R. 2011. The effects of drop height, conveyor velocity and contact surface material on area and volume bruising of "Golden Delicious" apple. Journal of Agricultural Machinery Engineering 2, 19-27.

[16] Timm E.J., Bollen, A.F., Dela Rue, B.T., Woodhead, I.M., 1998. Apple damage and compressive forcesin bulk bins during orchard transport. Appl. Eng. Agric. 14, 165–172.

[17] Van Zeebroeck M., Tijskens, E., Dintwa, E., Kafashan, J., Loodts, J., De Baerdemaeker, J. and H.Ramon, 2006. The discrete element method (DEM) to simulate fruit impact damage during transportand handling: Case study of vibration damage during apple bulk transport. Postharvest Biology andTechnology. 41(1): 92-100.

[18] Zhang W. 1994. Apple impact bruise analysis. Ph.D. Dissertation, Program in Engineering Science,College of Engineering and Architecture, Washington State University.