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Investigation of Post Harvesting Time and Size Effects on Tomato Mechanical Strength under Quais-Static Loading

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ABSTRACT

Reduce waste maintain quality of agricultural products and the optimal design of machines and processing equipment, knowing the mechanical properties are essential. In this study, using a Texture analyzer on the fruit of tomato, Early kind of CH, mechanical stress testing within a factorial experiment in completely randomized design factors independent of fruit size (S), at three levels, time after harvest (T), as well as three levels, on the mechanical properties, force and required energy to Relaxation percent of fruit, were studied. Analysis of variance showed that with increasing size of tomatoes, compressive power and energy increases with increasing time after harvest, but energy and relaxation force at the time (t_2) increased, but at the time (t_3) decreased. The interaction results show that the more fruit size is great, the compressive force and power of fruit were also increased and this effect for investigate relaxation feature (R %) till 24 hours after harvest for the average size would be increased but with time after harvest was reduced to 72 hours.
KEYWORDS: tomato, required compressive force, required compressive energy, relaxation.

INTRODUCTION

Many basic accomplished researches in the field of mechanical properties, including rheological with the aim of providing necessary information to reduce the waste caused by mechanical damage on crops has been made. one of the important parameters to reduce this waste, to be informed from fruit resistance against compressive pressures. Researches show that tomato fruit resistance against compressive forces varies with the size of the fruit, in this regard also reported as the size of fruit much larger, the resistance against compressive force will be more (Tavacoli Hashjin, T. 2004; Anthony et al., 2005; Aylar Mohammadi et al., 2009; Afkarisayah et al., 2009). in designing standard box to reduce static and dynamic damage to tomato fruit (Tahmasebi et al., 2008), in the laboratory by using three dimensional measurements perpendicular to the original, separated this fruit in three sizes (small, medium and large), and the results confirmed that the hardness or stiffness of big tomato fruit was 68.7 and for medium and small size, respectively 59.82 and 29.5 N.

Post harvesting time has an effect on mechanical properties. Researches show that in this regard only red tomato for 4 to 7 days in terms of temperature 8 to 10 degrees Celsius can be maintained, other findings also show there is complete correlation between time and the evaporation of moisture. Report the results of another investigation was, the maximum tolerable pressure of tomato fruit over time is low, and in other studies, it was found that with time after harvest, peach fruit resistance properties has declined,(Sargent et al, 2000. and Mohammadi Aylar, 2009).

Unfortunately, research on mechanical properties of tomatoes based on fruit size and time after harvest, hasn't been done. This study based on use of Rheologycal in relocation cases (including the harvesting operations, transport and processing) and storing agricultural products, food processing and determine desirability of food was carried out.

MATERIALS AND METHODS

In this study, to obtain the power characteristics of each fruit and energy failure, relaxation percent of tomato by the name PCH was used. At first, total 300 big and small tomatoes were collected randomly from a perfect red color. Early morning harvest was performed, 7 am, that

immediately samples carried to the Mashhad laboratory of Agriculture Research Center, and after 2hours the temperature of tomato fruit reached to constant temperature conditions (24 ± 2°C) but it was reported in other studies, that the time reaches product temperature in laboratory conditions is 30 minutes, (Sargent et al, 2000). In this study, first tomatoes in three different sizes were separated. Determine the size of each tomato with a caliper in three dimensions from a carefully (d_1, d_2 and d_3) with precision 0.1 was measured. Average size of the relationship between these dimensions in order No. 1distinguished (d_1- 43.89, d_2- 53.62, d_3- 61.73 mm), respectively. other also used from this method (Tahmasebi et al., 2008).

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$$D = (d_1 \times d_2 \times d_3)^{\frac{1}{3}} (1)$$

The treatments consisted of three tomato fruit size (s_1. small, s_2. medium and s_3. large), three postharvest time (t_1-2, t_2-24, t_3-72 h) in five recurrence were tested. Alassi, et al. (2008) also studied in times (0, 10and 20 days), and Mohammadi Aylar and colleagues (2009) in times (1-5-10 and 15 days) after harvest.

This research has been done by model system (QTS25) present in Agricultural Research Center in Mashhad, which has a potentiometer 25 kg with the ability to accurately measure power with precision 0.001. Others also have used Extensometer machine equipped with linear displacement transducer for their mechanical properties of tomato, (Antonio et al., 2005).

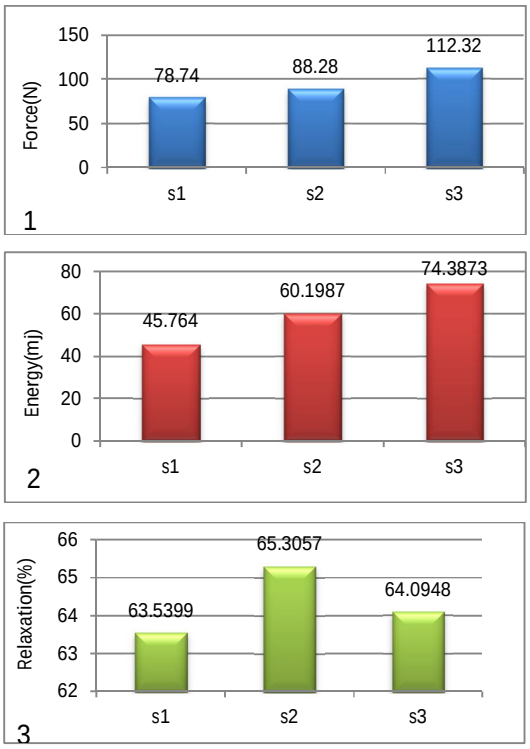
For measure the mechanical resistance of tomato against quasi-static loading used from loading speed 5 $_{mm}^{-min}$, until complete rupture stage, and for relaxation test, used from loading speed 30_{mm}^{-min}, with initial deformation of 10% for 60 seconds, which finally, with using the relation (2), the percentage and relaxation was calculated. Others in their research for some of the mechanical properties from loading speed 30 mm per minute and, different compression ratio between 4 to 20 percent, early fruit size tomatoes and similar relations used in this study (Antonio et al., 2005), But others in standard box designing of tomatoes, have tested from speed Reload 7 mm per minute, (Tahmasebi et al (2008).Statistical analysis was done on randomized complete block design applying the analysis of variance (ANOVA) using SPSS versions 17 software. The F test was used to determine significant effects of each treatment, and Duncan's multiple ranges test was used to separate means at a 5% level of significance. Energy calculations, energy and Relaxation percent, were calculated by computer.

$$R\% = \frac{F_{t1}}{F_{t0}} \times 100 \qquad (2)$$

Ft_0- Reload peak force after 3 seconds
Ft_1- Force at the time of 60 seconds after loading

RESULTS AND DISCUSSION

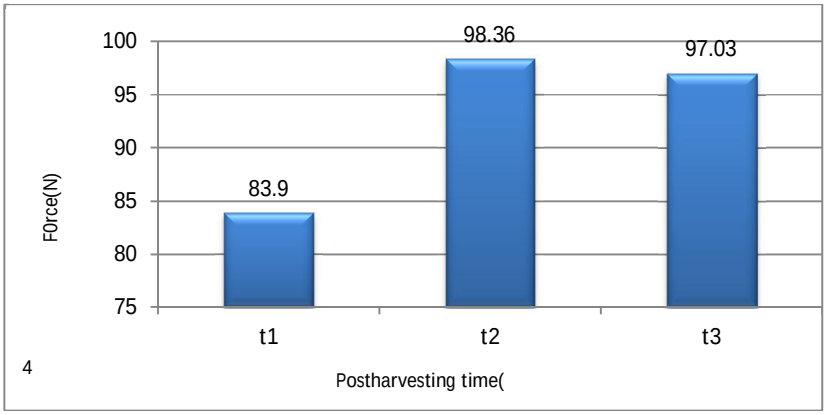
Vulnerability of tomato fruit is dependent on its size. Accordingly, average values of failure force, energy and relaxation for different sizes, from small to large, respectively, 78.74, 86.96, 112.27N, and 45.76, 60.2, 74.39 mg, and 63.54, 64.09, 65.31 percent, was obtained in this research, Figures (1, 2 and 3). In a similar study, average failure force for larger sizes are considered about 87.94 N, and for small size considered less, (Mohammadi Aylar, et al., 2009). The main difference is condition of production and testing time after harvest.

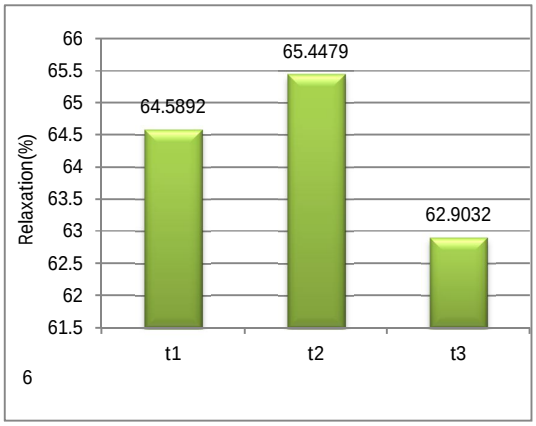


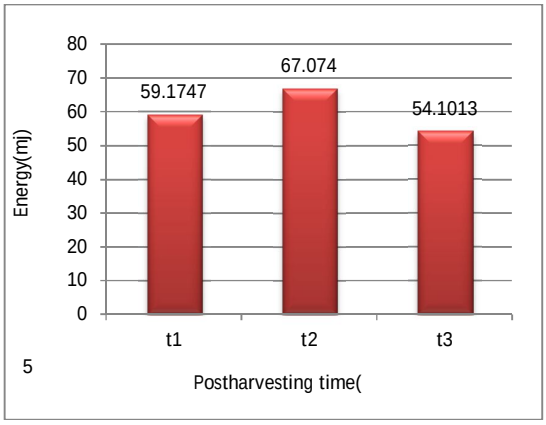
Figures 1, 2 and 3: Figure one, the fruit of power failure, No. 2, the effect of failure and fruit number three, relaxation percent of tomato fruit size.

Others research also the difficulty of small tomatoes have been considered less than enlarge, and it was determined between the order of 29.5 and 68.7 N; and in the one other research, reportde the biological yield point force about 38.5 N and fracture energy of fruit about 101.17 mg for medium size, with 12% compression (Tahmasebi et al., 2008; Zhiguo Li and Jizhan., 2010).

In study effect of force and postharvesting time, although over time, increased power was not significant, but the results of this study showed that there is direct relationship between the force and timeafter harvest (Figure 4), and Values respectively for the time t_3, t_2, t_1; 83.9, 94.44 and 99.64 N was obtained, The reason of increased strength was due to moisture fruit plasmolysis declined, so its strength will increase as in the same size. So in effect of postharvesting time, on each energy and relaxation traits, results showed that, 24 hours after harvest, it was increased, and then significantly decreased up to levels of 1%. (Figures 5 & 6).In study others at the time of 1, 5, 10 and 15 days after harvesting, power failure tomato fruit, respectively reported about 69.56, 67.81, 64.75 and 71.43 N, (MohammadiAylar et al, 2009).







Figures 4, 5 and 6.Effect of time after harvest on fruit and power and energy failure Relaxation percent.

In this study, it was observed, of fruit size and post harvesting time has a direct relation with power failure, the average force for small size at the time $t_1$was 70.16 N, this amount in time of t_3, determined about 88.58 Newton which had significant difference at 1% probability level, (Figure 7). Others reported in their review, that at times 0, 10 and 20 days after harvest, tomato fruit power failure has decreased; though the time specified in their experiments with time after harvest plan is different,(El-Assi et al, 2008).with others tests done on peach fruit have concluded that by increases the time taken from zero to 35 days, the resistance of fruit against force from 65 N at harvest time, was attained to 39 N, at 14 days after harvest, (Vursavus and Ozguven 2003). All other studies based on time after harvest, were on one of the characteristics of force and energy, regardless of fruit size. But this research based on over time with the size of tomato fruits was conducted.

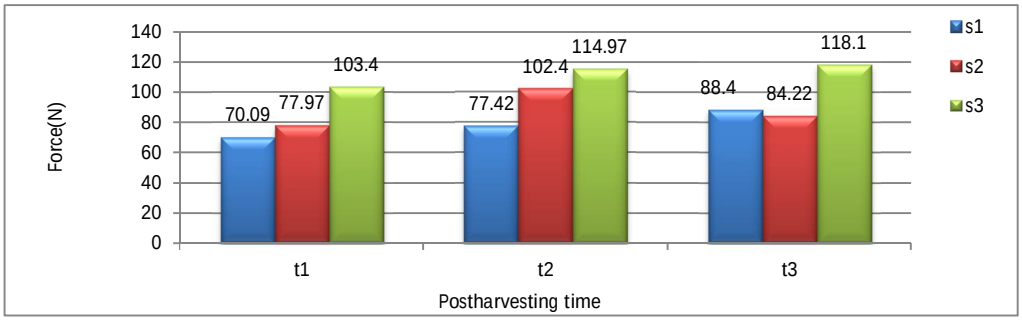


Figure 7. The Effect interaction fruit size and post harvesting time determine the power failure tomato fruit.

Also, in review interaction time after harvest and fruit size on the energy attribute, results showed that with increasing time after harvest and fruit size, fruit fracture energy increases. Only for medium-sized and large size at time 2 energy was reduced. This increase and decrease in energy had significant effect on more levels, (Figure 8). Maximum energy obtained 82.02 mj, for large size at the time t_1, and the lowest was 36.23 mj, for small size at the time t_3, respectively. This findings is consistent by research of Afkari Sayyah et al, (2009) on vulnerability of tomato.

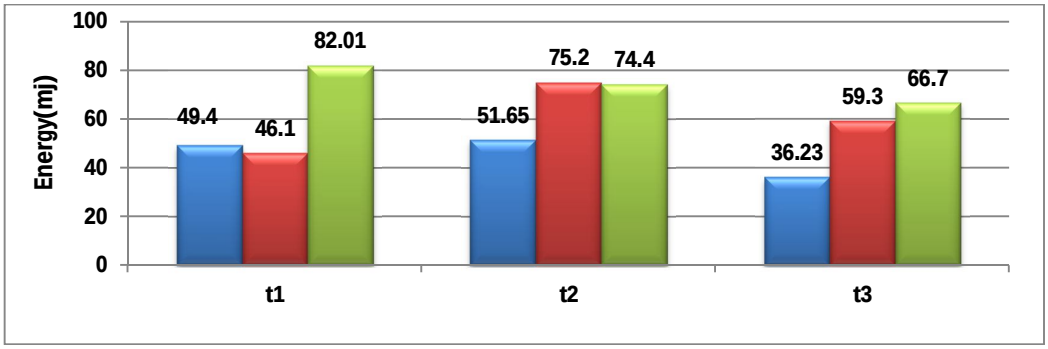


Figure 8. The Effect interaction fruit size and post harvesting time determine the Energy failure tomato fruit.

In examining the size and time interaction on the traits ofRelaxation percent the results of this study showed that increased fruit size to medium size, in each harvest time was increased, and thereafter, for the large size, the percentage was reduced Between levels (s_1*t_1) with (s_2*t_1) and also between (s_2*t_1) with (s_3*t_3) there was differences (Figure 9). (Alpha=0.05).

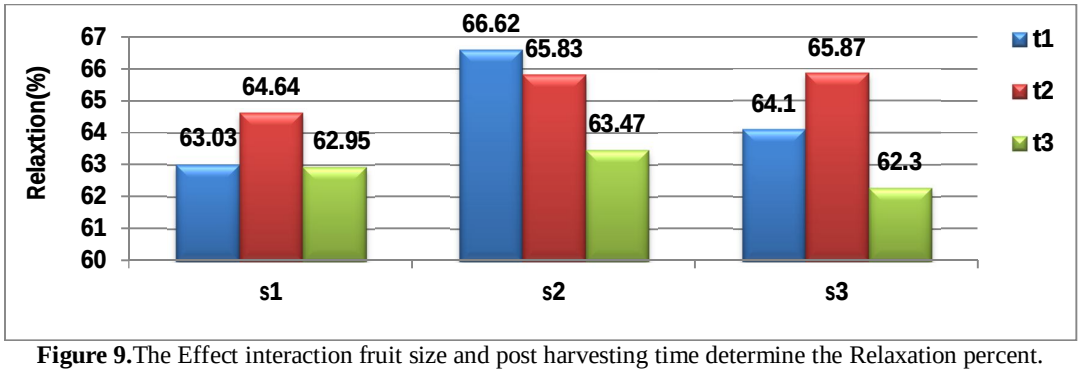


Figure 9. The Effect interaction fruit size and post harvesting time determine the Relaxation percent.

CONCLUSTIONS

1- Maximum power and energy for large size, respectively was appointed equal to 112.36 N and 74.39 mj, while this value for small size, respectively was 78.75 N and 45.76 mj. So picking fruit in packaging box and transportation and processing of them should be done accuracy we should be considered that smaller size of tomatoes set under less compressive force tolerance.

2- During 2 hours after harvest, force and energy necessary to failure of fruit at yield point, was respectively, 83.79 N and 59.17 mj, but at the time of 24 hours after harvest, this amount was increased and at time of t3, force and energy was reduced; Therefore for decide to use tomatoes and prevent further waste, also in keeping this product in stock and processing, we should considered them until 24 hours after harvest.Baryech (2000), found that bypassing of time, the load bearing fruit was declined, he advised that the majority of transfer and storage functions of product in the first week after harvest, which still mechanical strength of fruit has not dropped, should be accomplished.

3- Although by increase in fruit size relaxation percent would be increased but, with passing of time, this occurs after 72 hours of harvest was severely reduced. This also proves that at time, 24 hours after harvesting to packaging and transport is necessary otherwise the tolerance of tomato fruit against compressive forces being low.

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