An Assessment of Impact Damage to Fresh Tomato Fruits

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Abstract

An impact damage assessment of fresh tomato fruits was carried out to ascertain the effects of drop height, impact surfaces, maturity and size of fruits on bruise area and impact energy. Five different impact surfaces namely, cardboard (A), wood (B), metal (C), Plastic (D) and Foam (E) were used on the platform of the equipment. Tomato fruits of two maturity stages, fully ripe (80-100% red) and turning (1-50% pink) and two mass groups (30 -70 g as M1 and 1-30 g as M2). The fruits were dropped from different heights onto the different surfaces and the impact energy and bruise diameter were measured. The results show that impact damage measured in terms of bruise diameter is highly influenced by the impact surfaces. The metal surface inflicted the greatest impact damage on the fruits. The impact energy on the fruit is greatly influenced by the drop height and the mass of fruits. Fruits dropped from H1 (140 cm) absorbed the greatest energy indicating that they suffered the most impact damage. The results obtained can be used by designers of packaging materials, processing plants and handlers of fresh tomato fruits in Nigeria to reduce mechanical damage, especially those due to impact and ensure good quality products.

Keywords: *impact damage, tomato fruits, handling.*

Introduction

Fresh vegetables and fruits such as tomato are in great demand as they form part of the diet of millions of people the world over. The production of bulk of the fresh tomato fruits in Nigeria especially *roma vf* variety is in the Northern part of the country whereas the consumption and utilization is done all over the entire country. This calls for effective distribution, which involves long distance handling with associated mechanical damage especially that due to impact. The globalization of markets and the trend for some countries or areas to specialize in specific fruits encourage domestic and inter-state transportation (Berardinelli *et al*. 2005). Heavy losses are therefore incurred in the process. Although postharvest loss estimate figure for fruits and vegetables are difficult to substantiate especially in developing countries like Nigeria, it is however estimated that losses as high as 50 - 70% are common in the tropics between the production areas and consumption points (Oyeniran 1988).

The major cause of these losses is mechanical damage (bruising) due to impact. This impact could result from either vibration or sudden drop of the produce from certain heights. Over the years several studies were carried out to assess the mechanical properties and susceptibility to bruising of fruits and vegetables (Holt and Schoorl 1985; Olorunda and Tung 1985; Jones *et al*. 1991; Roudot *et al*. 1991; Singh and Singh 1992; Hyde *et al*. 1993; Ogut *et al*.1999; Vursavus and Ozguven 2004; Berardinelli *et al*. 2005). Impact sensitivity of fruits and vegetables was defined as having components namely bruise threshold and bruise resistance (Bajema and Hyde 1998). Bruising in fruits and vegetables occurs when the produce rubs against each other, packaging containers, parts of processing equipment and the tree (Altisent 1991). In the course of loading and offloading, the fruit loads or packages are at times thrown from certain heights on to other surfaces and this also results in impact damage. The economic implications of bruising are extraordinary (Anon. 1999).

Evidence of severe problems of mechanical damage is increasing and it is affecting the trade of these products. This is because there is great demand for high quality fruits and vegetables worldwide (Altisent 1991).

Reducing the amount of bruising can increase food safety by decreasing the potential for microbial infestation. Assessment of the processes from which most of the losses in fresh produce emanate is important if the produce quality is to be ensured. Impact in particular is very crucial in fresh fruits and vegetables handling because shock received by the products eventually determines the level of damage that has occurred. It is thus desirable to assess the level of bruising that occurs in fresh tomato fruits under certain conditions during handling. In particular, the various surfaces that fresh produce come in contact with and the height of drop of the packages during handling.

In this study, the effects of different impact surfaces and height of drops on bruise area and energy absorbed are investigated with the view to generate basic data/information that can be used in the design and management of handling and transport devices that will minimize mechanical damage to fruits

Materials and Methods

The materials and equipment that were used for this experiment include: measuring tape, electronic weighing balance, vernier calipers, oven drier, impact testing machine, impact surfaces (metal, wood, plastic, cardboard and foam).

Fresh tomato fruits (*roma* vf) of two maturity stages (turning and fully ripe) were obtained from a farm in *Gidan Kwano* near Minna Niger State, Nigeria. The samples were sorted into two groups based on the masses: M1: 31 -70 g; M2: 1- 30 g. An impact testing equipment developed by Ajisegiri *et al*. (2003) was used to drop the fresh produce from certain heights on to the impact surfaces placed on the impact platform of the equipment. Five different impact surfaces (cardboard-A; wood-B; metal-C; plastic-D and foam-E) were used. Five fruits from each of the mass groups and maturity stages were dropped on to each of the different surfaces placed on the platform of the equipment from four different heights: H1-140 cm; H2-110 cm; H3-80 cm and H4-50 cm. In order to ascertain the correct dimensions of the impacted area, some white powdered chalk were spread on the surfaces. The impacted fruits were coded and stored for three days and the dimensions (diameters and depths) of the bruised areas were measured.

The impact energy was determined from the relationship given by Mohsenin (1986)

$$E = (1 - e^2)mgh, \qquad (1)$$

where E is the impact energy, m is the mass of the fruit, g is the acceleration due to gravity, h is the height of drop, and e is the coefficient of restitution,

$$e = v_2/v_1 = (h_2/h_1)^2, \qquad (2)$$

where v_1, v_2 are the initial and rebound velocities and h_1, h_2 are the heights of fall and rebound respectively. For each of the impact surfaces, the samples were dropped from the various heights and bruise area and energy were determined at each of these combinations.

Results and Discussion

Bruise Area

Fig. 1 shows the results of the effects of impact surfaces, maturity and size of the fruits on the bruise area on the samples. One parameter that is used in determining impact damage in fruits generally is the bruise diameter. The average bruise diameters obtained were between 25 mm and 38 mm from which the bruise areas were computed. Earlier studies graded degree of impact damage in relation to average bruise diameter as follows (Vurasvus and Ozguven 2004): bruise diameter of less than 12 mm,the damage is classified as None; 12-19 mm: Trace damage; 19-25 mm: slight damage; 25-32 mm: medium damage and greater than 32 mm as severe damage. It can be seen from the results that the samples dropped onto the metal, wooden and plastic surfaces suffered severe damages. However, the metal surface seem to inflict the greatest impact damage on the fresh tomato fruits dropped onto it than any other surface used in this study followed by the wooden material. These materials are generally rougher and harder than the others. The foam inflicted the least impact damage.

It seems that the ripe and bigger fruits are more susceptible to impact damage than the small and turning fruits. These results agree with other studies carried out. Altisent (1991), revealed that severity of impact damage to fruits is primarily related to, the type of impact surface and size in addition to the physical properties of the fruits. Since the foam surface inflicted the least impact damage, it can be inferred from this study that in considering materials that can be used as cushioning materials in packaging tomato, the foam could be employed.

Fig. 2 shows the results of the effects of drop height, maturity stage and impact surfaces on the bruise area. The results show that samples of fruits dropped from height H1 (140 cm) on the metal surface suffered the greatest impact damage. Those dropped onto wooden surface closely follow this. It has been noted that damage inflicted on fruits is related to energy available for bruising and the characteristics of the products. The energy available is in turn related to the energy input to the system, suspension characteristic of the vehicle and the properties and the packaging of the fruits (Vurasvus and Ozguven 2004).

Impact Energy

Fig. 3 shows the results of the effects of drop heights, maturity and impact surfaces on the impact energy available for bruising. As can be clearly seen from the results, the samples of fruits dropped from height H1 (140 cm) absorbed the greatest energy. These results agree with other studies (Hyde *et al.* 1993) which revealed that as the drop height increased,

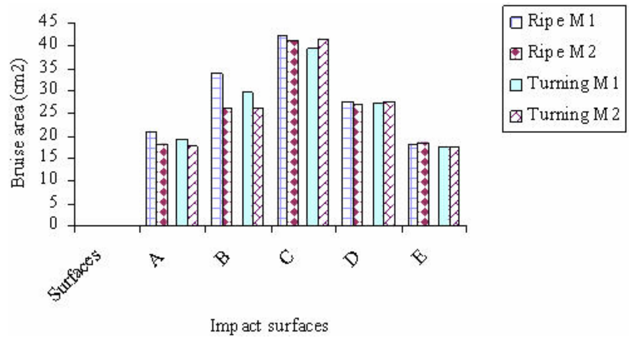

Figure 1. Effects of impact surfaces, maturity and mass on the bruise area on the fresh tomato fruits

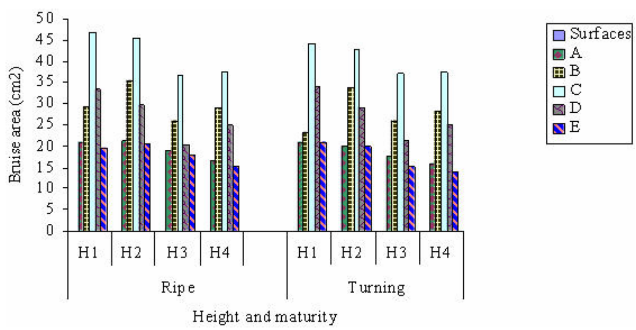

Figure 2. Effects of height, maturity and impact surfaces on the bruise area on the fruits

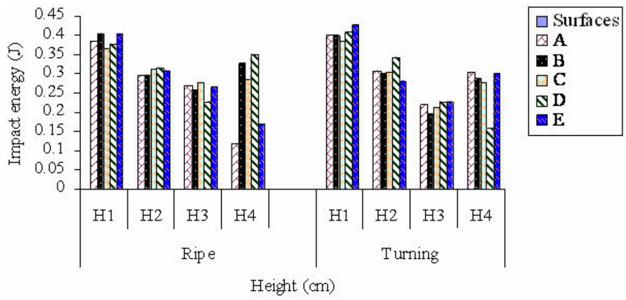

Figure 3. Effects of height of drop and impact surfaces on the impact energy on the fresh tomato fruits

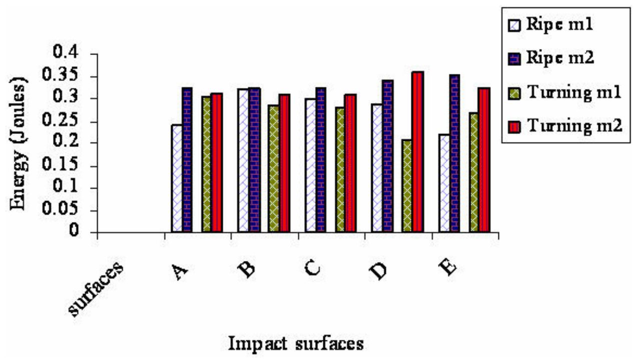

Figure 4. Effects of mass and impact surfaces on the energy absorbed by the fresh tomato fruits

the type of potato tuber bruise changed from blackspot to a combination of shatter bruise and tissue cracking. The energy and drop height are linearly related (see Eq. 1).

Energy absorbed by fresh tomato fruits greatly determine the quality of the fruits during handling and storage because the bruising of the tissues which results from such impact enhance subsequent deterioration of the fruits. Hence, if quality is to be ensured , this impact resulting in such damage must be minimized.

It will be recalled that in the course of handling and transportation of fresh fruits and vegetables in Nigeria, the handlers sometimes throw the packaged produce from heights as high as 3 m (lorry truck) on to the ground during offloading. This is sometimes responsible for the greater part of mechanical damage suffered by the fresh produce in transit resulting in produce loss and low quality products at the destinations. The practice of throwing the fresh tomato fruits package from very high point is not healthy for this produce as this can inflict higher impact damage. The information obtained from this present study can be of great help to designers and handlers of these fresh products in reducing incidences of mechanical damage especially those due to impact and ensure good quality.

The effects of the sizes and maturity of the fresh fruits on the energy absorbed can be seen from Fig. 4. The bigger and fully ripe fruits (M1) generally absorbed more energy than the smaller ones (M2). The effects of surfaces are, however, not well pronounced on the results of the impact energy.

Conclusion

An assessment of impact damage on fresh tomato fruits has been conducted by dropping the fruits from various heights onto different impact surface to see the effects on the bruise area and impact energy. It can be concluded from the experiment that bruise area is greatly influenced by the surface with which the fresh tomato fruit comes in contact. Metal material inflicted the greatest bruise area. The impact energy on the other hand is greatly influenced by the drop height and the mass of the fruits. The data obtained can be of great help to designers of packaging containers, processing equipment and handlers of the produce at various stages of distribution in minimizing the mechanical damage that may result especially those due to impact and ensure deliverance of good quality products to consumers and processors.

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