IMPACT BRUISE RESISTANCE OF PALM FRUIT

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ABSTRACT

This paper presents the dropping mass impact method to study bruise resistance and minimum absorbed energy to cause bruising on oil palm fruit, their variation values due to the differences of fruit fractions and transport delay time to palm oil processing unit. The result of the experiment indicated that the bruise volume correlated linearly with the absorbed energy produced by impact. The bruise resistance of freshly harvested fruits varied from (1.727 J/mm^3) to (0.511 J/mm^3) and the riper the fruit was the lower the value of bruise resistance. The bruise resistance decreased with the progress of transport delay time. The minimum absorbed energy of freshly harvested fruits ranged from 0.04 J for to 0.029 J. Generally the values of minimum absorbed energy decreased during 2 days transport delay time and then increased for all fruits except the very ripe fruit.

Keywords : bruise resistance, palm fruit, transport delay time

INTRODUCTION

Oil palm fruit (*Elaeis guineensis* Jacq) is one of significant commodities in Indonesia. In term of CPO production, now, Indonesia is the biggest with 17, 2 million tonnes followed by Malaysia with 16,2 million tonnes.

During harvesting and handling, oil palm fruit suffers numerous impacts. Impacts may commence when the bunch of fruits falls down striking ground's surface during harvesting. Handling causes fruits (in or off bunch) subjects to impacts of each others or impacts between fruits and various surfaces of equipment and handling facilities resulting fruit damage in the form of bruising. Bruising due to impacts is expected to be significant since a bunch of fruits can weigh between 10 to 40 kilograms each. This mechanical accident causes economical losses in two modes. First, bruising allows the content of cells of the influenced tissues, which is mainly oil, to escape. So this is material loss. Secondly when bruising occurs, the influenced tissues make contact to oxygen resulting Free Fatty Acid (FFA) which is most significant criterion of Crude Palm Oil (CPO). The higher fruit damage due to bruising, the higher of the FFA content of CPO and the lower of the CPO quality. The softer the fruit tissues expressed by fruit fractions the higher of fruit damage due to impact bruising. In order to eliminate or minimize damage caused by impact, bruising phenomenon on oil palm fruit needs to be studied.

This research aimed to study bruise resistance and minimum energy absorbed to cause bruising of various fruit fractions, and effect of transport delay time to palm oil processing unit on the bruise resistance and the minimum energy absorbed.

METHODOLOGY

Instrument Setting

The experiment was conducted at Agricultural Technology Laboratory, Department of Agricultural Technology, Agriculture Faculty, University of Bengkulu. The dropping mass impact method was employed in the experiment. Instrument used in the experiment consisted of iron ball with 2.20 cm diameter weighting of 44.66 gram, PVC pipe with 1.5 inch in diameter vertically mounted by two clamps at steel stand. The pipe was holed horizontally with interval of 5 cm from the bottom to place a pike lock to hold the iron ball when placing in side, providing different drop heights. During operation the iron ball was set at a certain drop height by locking it and a sample of oil palm fruit, laid and held firmly by hand, was placed at the pipe lower end. The iron ball was released by tiring the lock and then the ball struck the fruit against its cheek. In this case, rebound height was neglected and the energy absorbed was similar to the impact energy and calculated from equation (1) or (2) by zeroing h_2. The resulting bruise was sectioned and soaked in biological tissue stain to make bruise identification easier. Diameter and depth of the bruise were then measured to determine bruise volume employing equation (3).

Experimental Setting

Oil palm fruit, Tenera cultivar of different maturities (expressed in fruit fractions) originated from the same field was used for experiment. Four fruit bunchs were provided for every fruit fraction (fractions 0, 1, 2, 3, 4 and 5).

The fruit fractions were identified according to classification standard (Naibaho and Taniputra, 1986) indicated in Table 1.

Table 1. Ripening standard criteria for bunch of oil palm fruit

Ripening Level	Fraction	Fruitlet off bunch	Criterion
Unripe	00	No fruit	Cat eye
	0	1-12.5% outer layer fruits	Unripe
Ripe	1	12.5-25% outer layer fruits	Ripe
	2	25-50% outer layer fruits	Ripe 1
	3	50-75% outer layer fruits	Ripe 2
Overripe	4	75-100% outer layer fruits	Overripe 1
	5	Several inner layer fruits	Overripe 2

Fruit bunches were picked from the trees without dropping them to avoid damage. Sample of fruitlets were taken randomly from every side of each bunch. Sample of 20 fruitlets were taken to conduct impact test for every energy level. Impact tests were carried out a long the transportation delay (delay time) and detail of experimental setting was shown in Table 2.

Data Analysis

Bruise volume data were average for every energy level and regression analysis was employed to produce relationship between absorbed energy and bruise volume. Data were presented in the form of graphic where bruise volume and absorbed energy were plotted in X-axis and Y-axis respectively to find bruise resistance and minimum absorbed energy to cause bruise for each fruit fraction. It is important to note that this presentation follows mechanical principles, and perhaps mathematically not common. The values of bruise resistance and minimum absorbed energy was also plotted against delay time to study their behaviors during fruit transportation delay.

RESULT AND DISCUSSION

Bruise damages resulted by impact could be easily identified from the colour of affected tissues so that bruise measurement was able to be performed properly. The relationships between bruise volume and absorbed energy for the fruit freshly harvested (one day delay time) were presented in Figure 1. It is indicated that for all fruit fractions, the bruise volumes were linearly correlated with the absorbed energies, the higher absorbed energy was the higher bruise volume.

Figure 2 shows that bruise resistance decreased with the progress of fruit ripening, the bruise resistance of Fraction 0 was the highest (1.727 J/mm^3) and that of Fraction 5 (0.511 J/mm^3) was the lowest. In other word the softer fruit was the lower of bruise resistance.

In the case of minimum absorbed energy to cause the bruise, the values were decreased from Fraction 0 (0.04 J) to Fraction 3 (0.029 J) but then increased from this lowest value to Fraction 4 and Fraction 5 (0.037 J) as shown in Figure 3. This finding suggests that the outer layer of fruitlet got harder when fruitlet became overripe but its strength was not sufficient enough to prevent bruising indicated by the bruise resistances of Fraction 4 and 5 were lower than that of Fraction 3.

Figure 4 presents the relationship between bruise resistance with transport delay time. It is observed that for all fruit fractions, the bruise resistances decreased with the progress of the transport delay time, the harder the fruit the sharper decrease of the bruise resistance values.

Table 2. Detail of experimental setting

Fruit Fraction	Delay Time (day)	Impact Energy (J)					Sample Number (fruitlet)
0	1,2,3,4,5	0.0874	0,1311	0.1748	0.2185	0.2622	500
1	1,2,3,4,5	0.0874	0,1311	0.1748	0.2185	0.2622	500
2	1,2,3,4	0.0874	0,1311	0.1748	0.2185	0.2622	400
3	1,2,3,4	0.0874	0,1311	0.1748	0.2185	0.2622	400
4	1,2,3,4	0.0654	0.0874	0.1092	0,1311	0.1528	400
5	1,2	0.0654	0.0874	0.1092	0,1311	0.1528	200

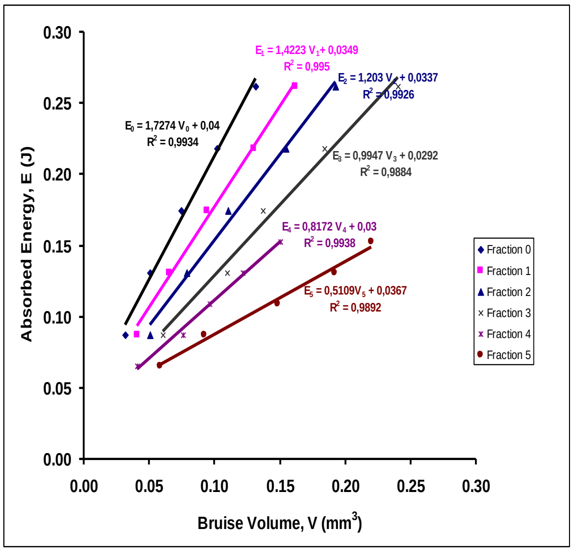

Figure 1. Relationship between impact energy with bruise volume for all fruit fractions.

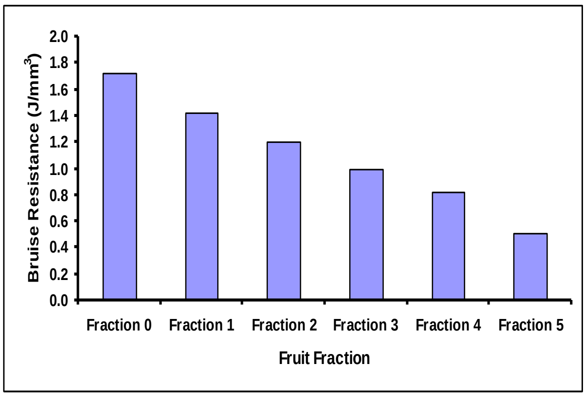

Figure 2. Relationship between bruise resistance with fruit fraction of freshly harvested fruits.

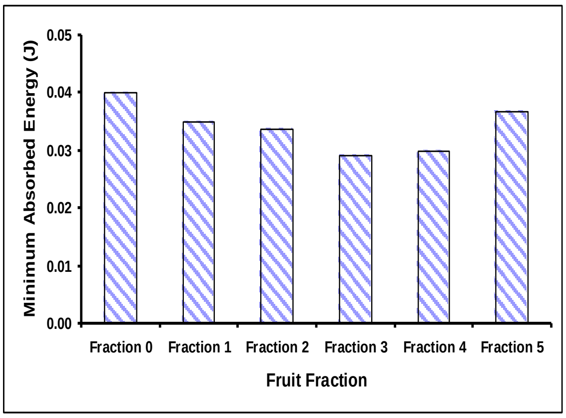

Figure 3. Relationship between minimum absorbed energy with fruit fraction of freshly harvested fruits.

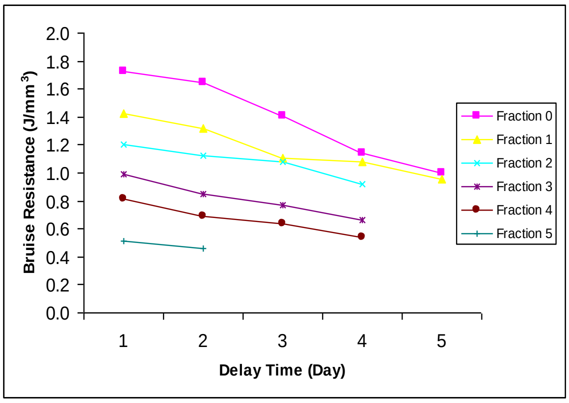

Figure 4. Relationship between bruise volume and transport delay time for all fruit fractions.

Figure 5 shows the relationship of minimum absorbed energy with transport delay time. The change of minimum absorbed energy varied among the fruit fractions. In general the values of minimum absorbed energy decreased during 2 days transport delay time and then increased for all fruits except the fruit Fraction 3. The minimum absorbed energy Fraction 0 (unripe fruit) decreased during 2 days transport delay time and then increased until 5 days transport delay time. This suggests that the outer skin of unripe fruit was getting softer while the fruit was fresh but it became tougher during ripening off the tree. This symptom is still observed in the fruit Fraction 1. It is interesting to note that the minimum absorbed energy for the fully ripe fruit (Fraction 3) was increased during the transport delay time while those of Fraction 4 and 5 were relatively constant. The minimum absorbed energy of Fraction 2 was sharply decreased during the transport delay time suggesting that the outer skin became fragile after the bunch had been detached from the tree.

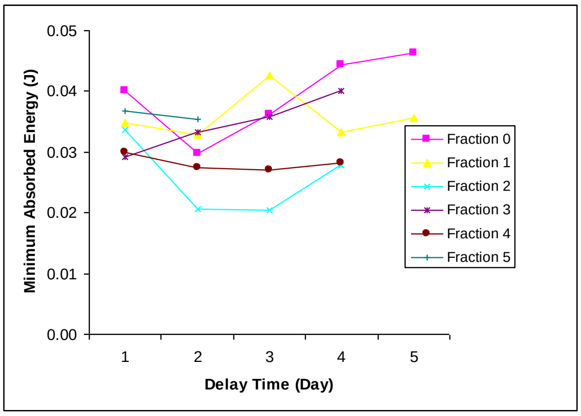

Figure 5. Relationship of minimum absorbed energy with transport delay time for all fruit fractions.

CONCLUSION

The result of the experiment indicated that the bruise volume correlated linearly with the absorbed energy produced by impact. The bruise resistance of freshly harvested fruits varied from (1.727 J/mm^3) to (0.511 J/mm^3) and the riper fruit was the lower the value of bruise resistance. The bruise resistance decreased with the progress of transport delay time. The minimum absorbed energy of freshly harvested fruits ranged from 0.04 J for to 0.029 J. Generally the values of minimum absorbed energy decreased during 2 days transport delay time and then increased for all fruits except the Fraction 3 fruit value. This last increasing value suggest that the outer skin of fruit got harder but it was not sufficient enough to increase the resistance of fruit from impact bruising.

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