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Relationship Between Fruit-stem Stiffness and Maturity of 'MONTHONG' Durians (*Durio zibethinus* Murr.)

Ratchada Chattavongsin and Jingtair Siriphanich

ABSTRACT

Fruit-stem stiffness is one of many maturity indices used by durian growers. A tool has been developed to objectively assess the maturity of durians according to this index. It is made of an "Effegi" firmness tester attached with a multiple plunger head, consisting of six cylinders of 1 mm diameter each. 'Monthong' durians were harvested at 104, 111, 118, and 125 days after anthesis for fruit-stem stiffness and maturity evaluation. The stiffness measurement was made by plunging the bark of the lower fruit stem with this tool. The reading was found related to days after anthesis, firmness and soluble solids content of the pulp, and number of phloem fiber in the bark. The possibility of using this tool to determine durian maturity is discussed.

INTRODUCTION

Durians was ranged first in value of fresh fruit exported from Thailand in 1987. worth about 10 million U.S.dollars (Anon., 1987 a.). The most important problem in exporting durians, up till now, is that large percentage of exported fruits were immature. Jarimopas et al. (1986) estimated the percentage of immature fruits to be as high as 30% of durians sold directly from orchards for exporting purpose.

At present, there is no acceptable objective index to determine the maturity of durians for suitable harvest, or for sorting of immature durians from lots of harvested fruits. Most durian growers and also durian merchants rely on subjective indices which are based on lifetime experience which include : the change in color of the husk and spikes which turn from green to greenish-brown, the development of lenticels on the spikes and on the fruit-stem, the enlargement of the abscission zone, the hollowed sound when knocking the fruit, the increasing stiffness of the fruit-stem, and the lightness of the fruit in relation to its size when lifted by hand (Anon., 1987 b.).

For objective indices, Natvaratat (1986) reported that specific gravity of 'Monthong' and 'Kanyaw' but not of 'Chanee' durians decreased as the fruit become mature. However, the specific gravity of both immature and mature durians was always lower than 1.0. This limits the use of the index. The most accepted objective index is the elasped of days from anthesis which is being promoted by the Department of Agricultural Extension. However, most growers still rely on their own experiences.

According to the authors' survey, stiffness of durian fruit-stem is generally believed to be one of the more accurate index. Jarimopas et al. (1986) reported that mature durian fruit-stem of 'Monthong' and 'Chanee' had higher mechanical resistance than that of the immature ones. Chattavongsin and Siriphanich (1987) also reported that as 'Monthong' and 'Chanee' durians become mature, a higher number of sclerenchyma cells in the cortex of the fruit-stem was seen. Our preliminary work indicated that fruit firmness-tester attached with cylinder shape plunger head of 1 mm diameter could be used to detect the increasing stiffness of the fruit stem by measuring the hardness of the bark. In the present study the use of a firmness tester, having combined plunger head of six cylinders of 1 mm diameter each, to determine the maturity of 'Monthong' durians, was reported.

MATERIALS AND METHODS

Young 'Monthong' durians were tagged at 7±3 days after anthesis in February 1988, in a private orchard, Klang district Rayong province. Ten fruits were harvested at 104, 111, 118 and 125 days after anthesis, and brought to the laboratory at Kamphangsaen in the same day.

Fruit-stem stiffness was measured by plunging the bark of durians fruit-stem with an 'Effegi' firmness tester equipped with a multiple head containing six

Department of Horticulture, Kasetsart University Kamphangsaen, Campus, Nakhon Pathom 73140, Thailand.

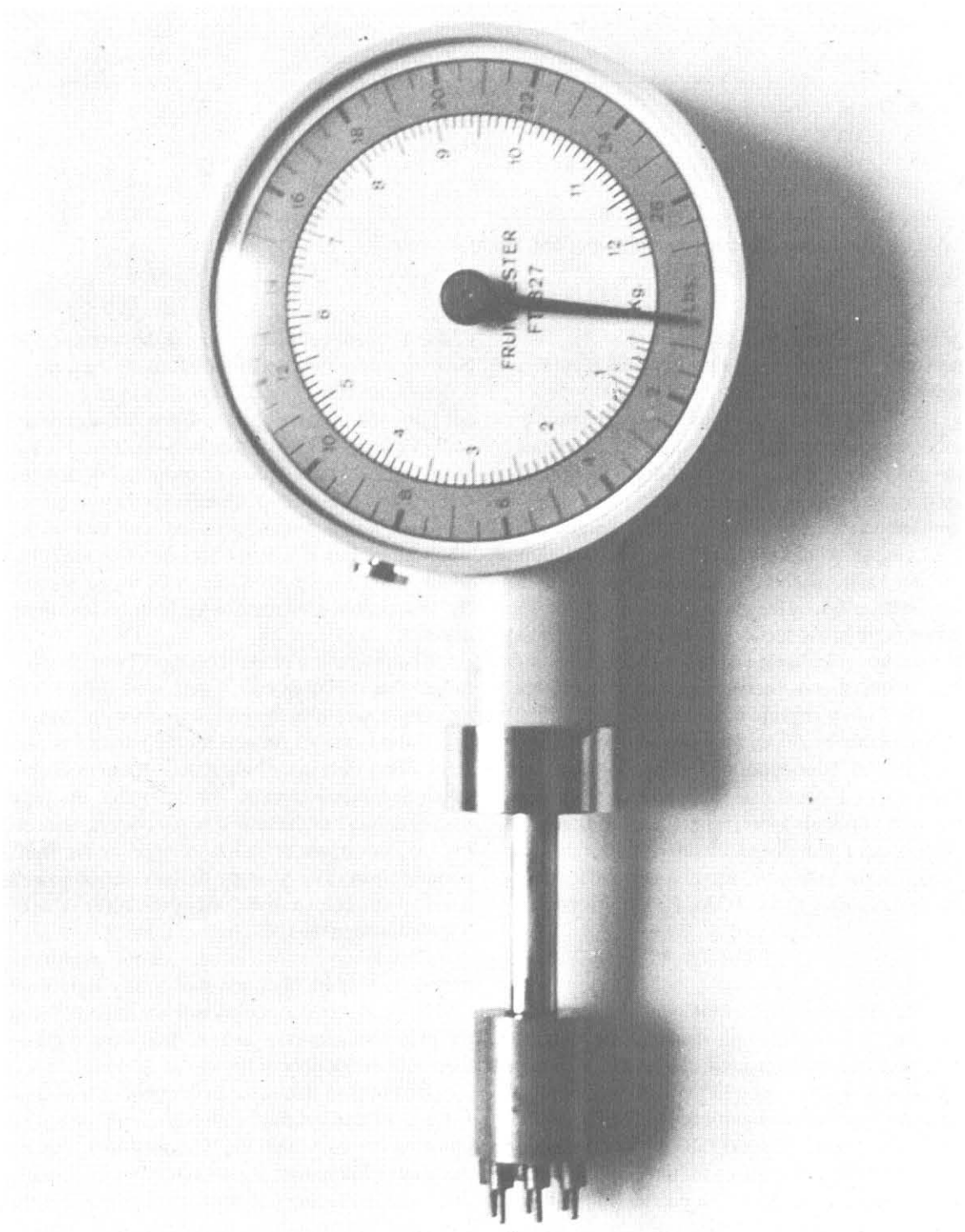

Figure 1 An 'Effegi firmness tester equipped with a multiple plunger head, each cylinder is 1 mm in diameter.

Table 1 **Fruit-stem stiffness, number of phloem fiber and stone cell in the bark of 'Monthong' durians harvested at different maturity.**

Days after anthesis	Fruit-stem Stiffness (kgf)	Phloem fiber (no/mm^2)	Stone cell (no/mm^2)
104	3.3 a	124 a	3
111	3.5 b	227 b	7
118	3.8 c	290 c	7
125	3.9 c	346 d	7

* Means separated by Duncan's multiple range test, 5% level

cylinders of 1 mm diameter each (Fig. 1). Three measurements were made on each fruit at midway between the abscission zone and the fruit.

Fruit-stem disks, 5 mm thick, were taken from the same area where the stiffness measurement was made. The disks were cut into wedges of about 5 mm wide, fixed immediately in 50% FAA solution and kept at room temperature until use. For slide preparation, the fixed samples were dehydrated with TBA solutions, infiltrated and embedded in paraffin according to the method described by Berlyn and Miksche (1976). The tissues were cross-sectioned (15 µm in thickness) with a rotary microtome and stained with Safranin-O and Fast Green, and observed under light microscope.

The fruits were kept in the laboratory (25-29°C) for 3 days then evaluated for : pulp color with a color chart (Royal Horticultural Society, London, and converted to 'x' coordinate in the CIE system); firmness with a firmness tester (using 5 mm head); soluble solids content with a hand refractometer by blending 1 part of durian pulp with 3 part of water; and for starch content according to the AOAC (1984) procedure.

RESULTS

The stiffness of durian fruit-stem, as measured by plunging the bark of the fruit-stem with the described tool, increased significantly from 3.3 kg in the most immature fruits to 3.9 kg in the fully mature ones. However, there was no significant difference between the last two maturity stages (Table 1). Small variation of ±0.15 kg was found among the three measurements done on each fruit stem. The anatomical work revealed that the structure of the fruit-stem was similar to most dicotyledonous stems. Many fiber cells were found in the phloem region. The number was only 124 per mm^2 in the least mature durians and significantly increased to 346 per mm^2 in the fully mature ones (Table 1). Stone cells were found in the cortex region but their number was not differred among the fruits of different maturity (Table 1). Qualitative change was not observed in these phloem fibers but secondary wall of the stone cells seemed to be thickened in the older fruits. No qualitative or quantitative changes were found in the xylem region except that the diameter of the whole region increased with that of the whole stem. In addition, the amount of tannin cells, which stained red with Safranin-O, in the phloem region appeared to increase as the fruits became more mature.

Characteristics of durian pulp (Table 2) confirmed that durian in each group were different in maturity. Except that there were similarity in the first two maturity stages. In general the younger durian fruits were firmer in the pulp texture, lower in soluble solids and starch content. For exception, the fully mature durian had the lowest starch content, indicating the conversion of starch to sugar as the fruits became ripen. The younger durians also appeared pale in pulp's color as indicated by the lower value of 'x' coordinate in the CIE system (Table 2).

Correlation coefficient between different parameters were quite high and statistically significant (Table 3). Better correlation was obtained between the pulp characteristics and the fruit-stem stiffness than with the number of days from anthesis.

It is concluded from the above data that fruit-stem stiffness of durians can be objectively measured by plunging the bark with the described tool. The increasing stiffness with durian maturity was partially due to the increasing numbers of phloem fiber in the bark of durian fruit-stem. High correlation between the fruit-stem stiffness and internal characteristics indicated that the developed technique could be used to assess durian maturity.

Table 2 **Firmness, soluble solids content, starch content and color of the pulp of 'Monthong' durians at different maturity evaluated 3 days after harvest.**

Days from anthesis	Firmness (kgf)	Color ('x' coordinate)	Soluble solids (%)	Starch (%)
104	4.3 bc*	0.36 a	9.2 a	20.6 a
111	4.8 c	0.36 a	9.8 a	21.4 a
118	3.8 ab	0.38 b	13.7 b	27.7 b
125	2.2 a	0.38 b	20.8 c	12.0 c

* Means separated by Duncan's multiple range test, 5% level

Table 3 **Correlation coefficient between fruit-stem stiffness, number of days from anthesis and the characteristics of the pulp and number of phloem fibers of 'Monthong" durians.**

	Days from anthesis	Color	Firmness	Soluble solids content	Starch	Number of phloem fibers
Fruit-stem hardiness	0.85**	0.82**	-0.70**	0.82**	-0.04	0.69**
Days from anthesis	-	0.76**	-0.57**	0.74**	-0.19	0.85**

** Significant at p = 1 %

DISCUSSION

The stiffness of the fruit-stem, as measured by the described tool, increased with the number of days from anthesis. It also had a high correlation with firmness, soluble solids and starch contents of the pulp. This indicated that the developed technique can be applicable. It is an objective procedure, cheap and easy to operate in the field. These are considered as the requirement for a good maturity index (Reids, 1985). Also, it can be used on every single fruit in both before harvest, to determine the maturity, or after harvest, to sort out the immature durians. Although, it left six small holes on the fruit-stem, it did not cause any serious damage to the fruit's quality. The scar can easily be hidden with a small sticker containing brand name or other information.

'Monthong' durians are normally harvested at about 120-130 days after anthesis. This index is not widely used by the growers at the present time. One reason is due to the flowering of durian which does not occur at one time. In one season, it can be as many as five set of flowering, resulting in five consecutive harvesting periods; not to mention the variation in each set. In our experiment, we found that durian fruit at 118 days after anthesis was of acceptable quality when ripen. If we take this 118 days after anthesis as the minimum maturity, using the average soluble solids content of 13.7% as a minimum requirement for mature durian, and taking fruit-stem stiffness of 3.8 kg as the criterion to determine whether the fruit is sufficiently mature. We found that out of the 40 fruits tested 6 were not correct. Thus we got an accuracy of approximately 85% in determining fruits maturity. The mistake of 15% is quite high in comparison with other fruits with well established harvest indices. However, if consider the estimation of upto 30% of immature fruits found in durians for export (Jarimopas *et al.*, 1986), the technique described here, can be benificial for durian growers, exporters as well as other partners involved. It must be noted, however, that the stiffness measurement obtained in this experiment was averaged from 3 readings on each fruit. For practicality it would be better to make the measurement only once. Although it will reduce the accuracy of determining durian maturity. A firmness tester having combined plunger head of 8 or more cylinders could be developed for a better determination of

durian maturity.

The proposed index rely on changed in the fruit-stem and in related to that occured in the pulp. Environmental factors such as weather conditions, growing location as well as cultural practices, which varies greatly, can influence the difference in the development of the two parts of durians. As a redult, a poorer correlation may be obtained.

The increasing stiffness of durian fruit-stem was thought to be the result of changes in both the wood (xylem) and the bark (pholem and cortex). However, in this experiment only the occurence of phloem fiber was observed. It is generally known that the amount of fiber tissue in plant increases as the plant become older, in order to support the increase in size and weight. Higher number of phloem fiber found in durian fruit-stem may have nothing to do with the maturity. Larger fruit may have bigger stem and higher number of phloem fiber than the smaller ones and hence have a stronger stem. Our observation in this experiment did not indicate that larger fruit had higher number of phloem fibers in the fruit-stem or stiffer (as measured by the tool) than the smaller fruits of the same maturity. They appeared to be related to maturity rather than the size of fruits. Nevertheless, durian growers notices that durian fruit from the younger trees are usually larger and also have stiffer fruit-stem. This internal and the environmental factors, as mentioned before, must also be tested for their effect on fruit-stem stiffness and the maturity of durians.

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