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Predicting storage life of sapodilla *(Manilkara zapota* L.*)* by non-destructive technique

(Ramalan jangka simpan buah ciku (*Manilkara zapota* L.) menggunakan teknik tanpa musnah)

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Key words: non-destructive technique, sapodilla, Kiwifirm device, storage life, firmness

Abstrak

Teknik tanpa musnah menggunakan peranti Kiwifirm berguna untuk mengesan peringkat kematangan buah ciku, meramal kualitinya apabila masak dan jumlah hari untuk kemasakannya. Garis kuasa ($Y= 0.02x^{3.6026}$) hasil daripada pantulan sentuhan peranti Kiwifirm dengan buah dapat dijadikan carta panduan untuk menjangka dan mengasingkan buah mengikut jangkaan tempoh simpan pada suhu 12 °C. Oleh itu teknik dan alat ini sesuai untuk mengasingkan buah kepada pelbagai gunaan, iaitu sama ada untuk simpanan, pemasaran mahupun untuk kegunaan semasa. Buah dapat diagihkan ke pasaran yang sesuai berdasarkan tempoh yang diambil. Strategi ini dapat digunakan untuk mempromosi buah ciku ke pasaran yang lebih jauh atau untuk eksport. Kehilangan lepas tuai ketika penyimpanan dan penghantaran dapat diminimumkan.

Abstract

Non-destructive technique using Kiwifirm device was useful in detecting the maturity stage of sapodilla fruit, predicting the quality at ripening stage and also days of the fruits to ripen. The power line ($Y= 0.02x^{3.6026}$) which was derived from the relationship of score resultant from the impact response of Kiwifirm device and duration for the fruit to ripen at 12 °C can be used as a chart to predict and separate the fruit according to the predicted storage duration. Thus the technique could be used to group the fruit into either storage-marketing and utilization purposes, or only suitable group for certain market. This strategy can be used to promote sapodilla fruit for distance market or export. Post-harvest losses, which occurred during storage and transportation can be minimized.

Introduction

Sapodilla, *Manilkara zapota* (L.) Royen *(Achras zapota* L.*)* locally known as ciku is a non-seasonal fruit, bears flowers all year round and flowering is more profuse after rain. Sapodilla is considered as one of the best tropical fruits in terms of taste and was quoted as a potential crop for subtropical climate (Michelbart 1996). Harvestable maturity of sapodilla fruit is around 7–8 months from flowering, depending on cultivar and environmental conditions during fruit development (Abdullah and Ahmad Tarmizi 1992). Sapodilla, when fully ripe is delicious and is eaten fresh or as a dessert.

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Normally sapodilla is harvested at commercial maturity and must be allowed to ripen before it can be sold in the market within a short period. Maturity of sapodilla can be judged by several external symptoms. But in commercial practices, these criteria are difficult to follow because of several reasons, for example, harvesting has to be done very fast, the fruits are in different stages of maturity even on the same stalk and it becomes worse when some fruits are very high on the tree. These practices create problems during storage and handling of the fruits.

The harvest maturity of sapodilla has a significant role in the post-harvest behaviour of the fruits. If harvesting is done at an appropriate degree of maturity, fruit ripens within 3–7 days at ambient temperature with excellent quality attributes. Fruits picked at immature stage are of poor quality when ripen. Over-matured fruits are vulnerable to handling and have short shelf life due to rapid degradation metabolism (Selvaraj and Pal 1984). The fruit is climacteric in nature and hence needs careful post-harvest handling to minimize losses after harvest (Roy and Joshi 1997).

The storage period of mature sapodilla fruits depends upon respiration rate and storage environment. Low temperature storage can extend the shelf life of sapodilla fruits by reducing oxidative metabolism and ethylene production (Lakshminarayana and Subramanyam 1966). At 10 °C, RH 85–90%, sapodilla can be stored for 3 weeks (Latifah 1989). Prolonged storage caused chilling injury, which was obvious after fruits were transferred to ambient temperature. The chilling injury symptom is either fruits become too soft or fail to ripen (Latifah 1993).

During packing or before storing, it is necessary to group the fruits according to the storage ability as the fruit varies in the stage of maturity. The uniformity of the fruit in terms of maturity stage, quality and grade makes the fruit more attractive and acceptable. This practice will minimize handling problems of sapodilla fruits. A non-destructive technique for assessing the criteria is very useful at this stage. Predicting the quality and days to ripen during packing will be easier if a tool is available or developed. The aim of this study is to investigate the use of Kiwifirm device for predicting the storage life of sapodilla.

The Kiwifirm device is used to measure the impact on the fruit by a small spherical impacter of known mass and radius of curvature and measuring the acceleration of the impacter. The advantage of this method is that the impact-force response is independent on the fruit mass and is less sensitive to the variation of the radius of curvature of the fruit (Chen 1995).

Materials and methods

Matured sapodilla fruits cv. Subang used in the study were obtained from MARDI farm at Serdang, Selangor. Fruits were harvested individually using secateurs. About 2–3 mm stalk was allowed to remain on the fruits. Plastic containers were used for collecting the fruits at the farm.

On arrival at the laboratory, sapodilla fruits were washed with water to remove the extraneous matter and excessive latex. The fruits were then air dried before being placed on the fiberboard tray (egg's tray). Fruits were stored at 12 °C with the relative humidity of 85–90%. Non-destructive technique using Kiwifirm device (Ab. Aziz et al. 1999) was used to measure the firmness of the fruit. Measurement was taken daily *(Plate 1)*.

Non-destructive firmness measurement

Kiwifirm device was used to measure the impact response from the sapodilla fruit. This prototype handheld device was developed by Industrial Research Limited, New Zealand. The principle involved in the firmness reading is that a known quantum of energy is applied to the fruit surface through a small, non-penetrating tip. The built-in processor converts characteristics of the

resulting collision to display a value, which has been calibrated to equate to a texturemeter reading. Four readings, which represent a replication, were taken on opposite sides of the equatorial position of the sapodilla fruit.

The number of days taken for the sapodilla fruit to ripen was recorded when Kiwifirm device indicated the score of 2.5–2.8 (Ab. Aziz et al. 1999).

The power line curve was fitted by computer calculation using Microsoft Excel software. From the curve, days of sapodilla to ripen were compared to the score given by Kiwifirm device.

Results and discussion

Sapodilla fruits are considered ripen when Kiwifirm device reached the score of 2.5–2.8 (Ab. Aziz et al. 1999). At this score the fruit has attained maximum edible quality and is ready to be consumed.

The relationship of Kiwifirm score versus days to ripen for sapodilla fruits stored at 12 °C is shown in *Figure 1*. The power line indicated that the days to ripen equal to $0.02x^{3.6026}$, where x is the initial Kiwifirm score. Fruits having initial kiwifirm score of 4.6–5.5 ripen earlier (on day 7) compared to the other fruits with higher kiwifirm value. The higher the initial Kiwifirm scored, the longer is the time for the fruits to ripen. This was shown by the fruits with initial kiwifirm score of 6.6–7.0 at harvest that ripen after 3 weeks with the R^2 value at 0.7147 *(Figure 1).* Ripe fruits, with initial score of 6.0 and above are not well accepted (Ab. Aziz et al. 2000)

Figure 1 can also be used as a formulated chart for a reference at the packinghouse. This enables the sapodilla fruits to be grouped into boxes according to days to ripen. This will facilitate the

Plate 1. Sapodilla fruits placed on the fibreboard tray for firmness measurement using the Kiwifirm device

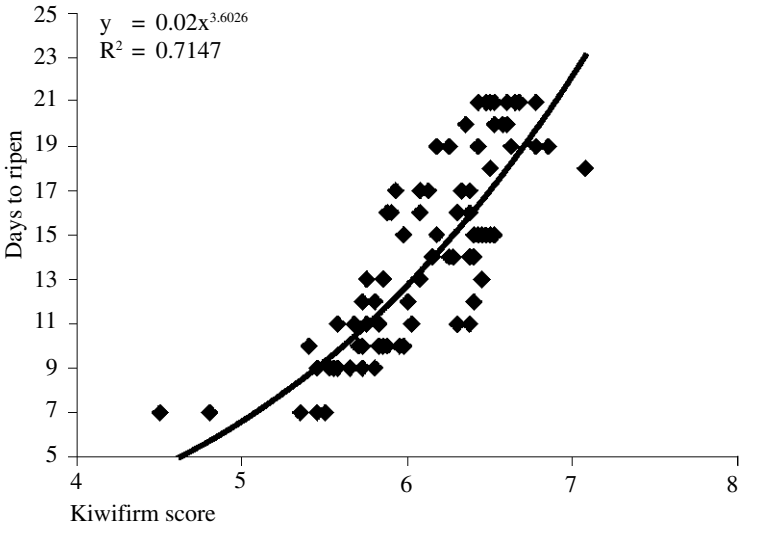

Figure 1. Relationship between kiwifirm score and days to ripen in ciku fruit var. Subang, at storage temperature (12 °C)

distribution according to storage or marketing purposes.

Conclusion

Identifying maturity stage of sapodilla at harvesting is very difficult as no colour changes occur during development and ripening process (Ab. Aziz et al. 1999). Fruit maturity also varies even in a single cluster. These factors create significant problem during packinghouse operation. Kiwifirm, is one of the non-destructive devices that can provide practical solution to overcome these problems. With the device, different stages of fruit maturity can be separated according to storage-marketing-utilization purposes. From the initial score, the storage life and the time taken to ripen can be predicted with great precision.

Non-destructive inspecting method using Kiwifirm device serves as a better, faster and reliable alternative for evaluating the internal quality of sapodilla fruit. It does not penetrate the skin or damage the underlying flesh of the fruit. This technique allows the testing of every individual fruit, and repeated testing of the same fruit. This will improve prediction of storage life, thus provide many advantages for researchers and the industry alike. The packinghouse operators can also plan their product either to send for marketing or storage purposes. Obviously it is very useful when the device can predict which fruits were going to ripen during storage.

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