



**UNIVERSITI PUTRA MALAYSIA**

**DETERMINATION OF BASELINE QUALITIES OF MALAYSIAN  
EXPORT-GRADE STARFRUITS**

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**DETERMINATION OF BASELINE QUALITIES OF  
MALAYSIAN EXPORT-GRADE STARFRUITS**

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**MASTER OF SCIENCE  
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**DETERMINATION OF BASELINE QUALITIES OF MALAYSIAN EXPORT-  
GRADE STARFRUITS**

**By**

**NORHASHILA BINTI HASHIM**

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A study was conducted to determine the baseline qualities of Malaysian export-grade starfruits. The study is focused on the B10 cultivar of starfruits for the range of colour indexes between 2 and 4, targeted for the export market. A total of 123 commercially-graded, B10 cultivar starfruits were selected randomly and their properties namely length, diameter, mass, volume, the five colours values (L, a\*, b\*, C, h°), firmness, TSS (Total Soluble Solids), TA (Titratable Acidity) and pH were measured directly. From these properties, further properties were derived by calculation to make up a total of 31 properties investigated. Outlier analysis was conducted and four outliers identified by samples number 94, 95, 97, and 109 were eliminated. Therefore, the remaining samples for further analyses became 119. Studies on these 119 samples show that the properties length, diameter, mass and hue have low coefficient of variation (CV) levels. The fact that the starfruits were the actual marketable products indicates that mass and hue are sufficient element for quality indicators. Mass and hue were 15<sup>th</sup> and 3<sup>rd</sup> respectively in ranking by CV. Correlation studies revealed that mass has a very strong correlation with volume while hue has strong correlation with firmness. The property, pH, could be



predicted moderately by  $b^*$ . Since the study was conducted on export-grade starfruits, the minimum values can be taken as baseline values for acceptance of export-grade starfruits.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**PENENTUAN KUALITI GARIS ASAS BAGI BELIMBING BESI GRED-EKSPORT MALAYSIA**

Oleh

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Kajian telah dijalankan untuk menentukan kualiti garis asas bagi belimbing besi gred-eksport Malaysia. Kajian ini fokus kepada belimbing besi baka B10 dari taburan indeks 2 dan 4, yang disasarkan untuk pasaran eksport. Sejumlah 123 gred-komersil, belimbing besi baka B10 telah dipilih secara rawak dan ciri-ciri buah iaitu panjang, diameter, berat, isipadu, lima nilai warna ( $L$ ,  $a^*$ ,  $b^*$ ,  $C$ ,  $h^\circ$ ), ketegaran, TSS (Jumlah Pepejal Terlarut), TA (Kebolehtitratan Asid) dan pH telah diukur secara langsung. Daripada ciri-ciri ini, ciri-ciri lain telah diterbitkan melalui pengiraan, menjadikan jumlah ciri yang dikaji sebanyak 31. Analisis outlier telah dijalankan dan empat outlier yang telah dikenalpasti daripada sampel nombor 94, 95, 97, dan 109 telah disingkirkan. Oleh itu, sampel yang tinggal untuk kajian seterusnya adalah sebanyak 119 sampel. Kajian terhadap 119 sampel ini menunjukkan bahawa panjang, diameter, berat dan warna tampak mempunyai tahap nilai pekali variasi (CV) yang rendah. Oleh sebab buah belimbing besi tersebut adalah produk yang boleh dipasarkan, ia menunjukkan bahawa berat dan warna tampak adalah elemen yang mencukupi sebagai penunjuk kualiti. Berat dan warna tampak, masing-masing



berada di tangga yang ke 15 dan ke 3 di dalam senarai CV. Kajian kolerasi menunjukkan bahawa berat mempunyai kolerasi yang kuat dengan isipadu manakala warna tampak mempunyai kolerasi yang kuat dengan ketegaran. Ciri pH diramal pada tahap sederhana melalui  $b^*$ . Memandangkan kajian ini telah dijalankan terhadap buah belimbing besi bagi gred eksport, nilai minimum boleh diambil sebagai garis asas bagi penerimaan gred eksport buah belimbing besi.

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I certify that an Examination Committee met on 1 August 2008 to conduct the final examination of Norhashila binti Hashim on her Master of Science thesis entitled “Determination of Baseline Qualities of Malaysian Export-Grade Starfruits” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree.

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## **DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any degree at UPM or other institutions.

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# CHAPTER 1

## INTRODUCTION

Starfruits were introduced and commercialized into the world market more than 100 years ago and is one of the tropical fruits that establishes well in the market. It is Malaysia's most exported exotic fruit, which is mostly marketed overseas (Dass et al., 2005). The demand for this fruit increases yearly and sometimes exceeded supply capacity (Dass et al., 2005).

Before exporting to other countries, the starfruits must be inspected for quality. Quality is a term that is important in postharvest handling, lacking which, market expansion for fresh produce can be affected. The definition of quality depends on different perspectives in the distribution chain and is influenced by the intended use of the product such as for fresh consumption or for processing into jams, jelly, juices, etc., the level of technology used, and economics.

Starfruit quality is determined during the sorting and grading processes. In Malaysia, these processes are carried out manually through visual inspection. This manual method depends very much on the perception of the individual worker which probably is the cause of a wide range of variability in measurement, thereby affecting consistency in fruit quality. Development and improvement in the measuring method are needed in order to achieve a high quality level and maintain market demand for this fruit.



## 1.1 Market Potential of Starfruit

A typical foreign demand for starfruits is reported to be five containers (15 to 30 million fruits) per week (Dass et al., 2005). Nevertheless, this demand cannot be fulfilled due to the limited production capacity. The export value of starfruit increases from RM27.7 million in the year 2000 to RM31.3 million in 2003 (Table 1.1) with an overall export growth of 13.2% for the year 2000 to 2003.

**Table 1.1: Export of starfruits for year 2000 to 2003 in millions of Ringit (RM)**

Countries	Year 2000	% of export	Year 2003	% of export	Growth rate (%)
Netherlands	13.7	49.5	20.3	64.9	48.2
Singapore	3	10.8	3	9.6	0.0
Germany	3.1	11.2	2.2	7	-29.0
France	3.4	12.3	2.6	8.3	-23.5
United Kingdom	1.3	4.7	0.4	1.3	-69.2
Hong Kong	0.4	1.4	0.4	1.3	0.0
Belgium	0.8	2.7	0.1	0.3	-86.8
Others	2	7.2	2.3	7.3	15
Total	27.7	100	31.3	100	13.2

Source: Dass et al. (2005).

Malaysia has an advantage over other competitors such as Taiwan and Israel, which can only cultivate starfruits seasonally in summer, in that Malaysia's tropical climate allows for the production of the fruit all year round (Dass et al., 2005). Previously, farmers were not keen to grow starfruits as the local market price for producing them was unstable being between RM2 and RM3 per kg (Dass et al., 2005). However, this fruit can now fetch a price of more than RM14 per kg in summer and up to 15% more during winter in Europe (Dass et al., 2005). Besides that, the starfruit tree is reported to have a life span of about 40 years, making it a long-term crop (Dass et al., 2005). Starfruit also has been a



popular home garden tree in Florida for a long time because of its good adaptation to the climate and the distinctive shape of the fruit (Crane, 1993).

## **1.2 Quality Issue in Post-harvest Handling of Starfruit**

Malaysia's starfruit industry began in the late 70s and since then the country has maintained her position as the largest starfruit exporter in the world. However, the low technology level in current quality assessment may affect this status.

The visual evaluation technique employed in Malaysia was conducted by human workers or expert judges. According to Ryall et al. (1974), this is a rapid and easy technique and has not yet been equalled by any machine. However, the effectiveness of this technique depends very much on the competence of the sorters and special attention is needed to avoid inconsistent performance, which can affect the quality standard of starfruits. The evaluation is very subjective and can be influenced by several factors such as colour and light intensity where changes in these factors can change the image received by the eye. Being a subjective evaluation, the exact hues or intensities of colour are difficult to describe and human eye estimation often is inaccurate. This subjective and poor repeatability method causes variations in results giving rise to non-uniform quality of the product. Bollen et al. (1993) reported that the ability of a human being to perceive a visual image depends on the cognitive factors of the person whose visual acuity decreases with age but can be increased by increasing the brightness of the test object. A 60-year



old worker may require about twice the brightness level than a 20-year-old worker for an equivalent visual acuity.

The current practice of sorting starfruits is based on the physical properties of the fruits namely, mass and colour. It was noted that the fruit size (i.e. length, diameter and mass) is often a variable (O'Hare, 1993; Wills et al., 1989) and the combination of this parameter such as mass with other properties such as colour are unable to determine the internal quality of the fruit such as sweetness and sourness. To a consumer, sweetness and sourness are usually perceived as a measure of quality. However, these parameters require a destructive measuring method which damages the fruit, rendering them unsuitable for sale. Currently, suitable non-destructive measurement methods for these parameters have not yet been found. It is thus vital that a reliable, non-destructive quality evaluation of starfruit quality be developed if the lead in the industry is to be maintained.

Nowadays, consumers generally are becoming more quality-conscious and demand more than just surface quality or physical appearances of the fruits. This development is fuelled largely by changes in consumer demand resulting from increased public interest in nutrition and health (How, 1993). This increased interest contributes to a continuous need for a new approach or an improvement in quality determination. Changes occurring in consumer demand for food are also due to changes in lifestyle, taste and preferences. With this scenario, it would be advantageous to measure a fruit's internal quality non-destructively and market it as a premium product (Miller et al., 2004). Technologies that could sort fruit for texture and flavor would assure fruit quality and consistency, increase



consumer confidence and satisfaction, and enhance the competitiveness and profitability in the fruit industry (Lu et al., 2002). A method must be developed to measure real quality factors in starfruits such as flavour and texture together with visual appearance.

### **1.3 Importance of the Study**

Quality is important at every level of the distribution chain, from the farmers down to the wholesalers, importers, exporters and finally consumers. Therefore, the improvement of current practices for quality determination will help every level of the distribution chain.

The current practice of manual sorting and grading probably contributes considerably to the variation in the quality of starfruits. MARDI (1989) reported that almost 50% of the selected starfruits were misgraded for the European market during the sorting and grading processes. If grade tolerance were exceeded, the packed fruits would be rejected, necessitating regrading and repackaging operations at either wholesaler or retailer levels, which would then contribute to increase in production cost and wastage of time. The misgraded fruits then were sold in local market. The application of objective numerical quality specification could solve the variation in starfruit quality while the analysis of correlation between the properties could help find the best indicator and predictor for starfruit quality. Hopefully, the findings of this study would help towards achieving accurate and rapid determination of quality and increasing the confidence level of retailers in distributing the fruits to the consumers. It is also hoped that the findings could also help increase the understanding of starfruit properties and promote the development



of auto sorting machines or systems for sorting processes through feeding information on property tolerance for each property and correlation between the properties to the system.

A good quality product will raise consumer's acceptance which in turn increases market demand. Not only can consumers buy them without any doubtful feeling but they can also pick the fruits quickly without having to search for the right ones amongst the pile, thus saving their time.

#### **1.4 Objectives**

The aim of this study is to establish a baseline quality for starfruits. The specific objectives are as follows:

- a) To investigate the variability in the properties of starfruits marked for export.
- b) To investigate the relationship between colour, firmness, sugar content, total acidity and pH and the physical properties of starfruits.
- c) To identify possible equations for predicting the internal properties of starfruits.
- d) To identify properties for determining baseline qualities of starfruits.

#### **1.5 Scope and Limitations of the Study**

This study is focused on the B10 variety of starfruits for the range of colour indexes between 2 and 4, targeted for the export market.





## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Starfruit

Starfruit is undoubtedly one of the most unique creations of nature. The fruit is showy, oblong and has uniform and symmetric shape with five longitudinal ribs (Morton, 1987; O’Hare, 1993; Crane, 1993). When cut across, it will form a star-shaped section that gives rise to the common name “starfruit” (Morton, 1987; O’Hare, 1993).



**Figure 2.1: Starfruits**