

## Specific Gravity of Commercial Stage of Taiwan Jujube Fruits (*Ziziphus mauritiana* Lamk.)

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Key words: Maturity; Specific gravity; Total soluble solids; Color values

### Summary

In this study, specific gravity of jujube fruits was investigated by using pure water. The percentages of floating fruits, on the pure water, of cv. 'Kaohsiung No. 11', 'Jin-Tao' and 'Zhong-Yue' with specific gravity < 1 were 99%, 98.4% and 90% respectively. There was no correlation among specific gravity total soluble solids and fruit firmness. Neither was total soluble solids and peel color. This study showed that specific gravity might not be a good indicator for prediction about harvest stage.

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## Introduction

One of the attribute which contains information relating to the internal quality of fruits and vegetables which can be used for non-destructive quality evaluation is specific gravity. Specific gravity grading has been employed by farms for some agricultural products since ancient times (Koro, 1997). It is considered a reliable indicator for harvest timing (measure of maturity), and this is attributed to a decrease in specific gravity with increasing intercellular spaces. Fruit specific gravity decreased continuously from fruit set to harvest (Bal, 1981). Elhadi (2011) also indicated that specific gravity decreases as the fruit matures.

Jujube fruits are usually eaten fresh and fruit colors change from green to yellow to chocolate brown with the maturity and ripening. It is important to harvest jujube fruits at the optimum stage of maturity (Pareek, 2013; Azam-Ali *et al.*, 2006). This study was set up to determine the correlation between specific gravity and the fruit quality of commercial fruit stage.

## Materials and Methods

### Plant materials

Taiwan jujube fruits were harvested from the orchard of Mr. Wang in Alian district, Kaohsiung city, Taiwan and transported to Department of Horticulture, National Chung Hsing University. The fruits were selected for uniform size and free of defects.

### Experiments

Jujube fruits were harvested in the commercial stage by dipping jujube fruits in pure water, specific gravity of a fruit was roughly estimated at less than 1.00 for floating fruits and over 1.00 for the sinking. Then fruit firmness, total soluble solids and peel color were all examined for the relationship between them.

#### 1. Firmness

Fruit firmness was estimated on opposite sides of fruit (including fruit peel) by using a penetrometer (Effegi, FT 327, Wilson, Italy). Data are expressed as (N/cm<sup>2</sup>).

#### 2. Total soluble solids

Total soluble solids (TSS) content of jujube fruits was determined by using a digital handheld refractometer (Palette, PR-32, Atago, Japan). Data are expressed as (°Brix).

#### 3. Colorimeter

Fruit skin color was determined by Hunter Lab Colorimeter (Miniscan XE Plus, MSXP-4500, USA). Measurements were taken on opposite sides of each fruit. The color was determined by using a CIE L\*, a\* and b\* color system where the lightness, L\*, represents the darkest black at

$L^* = 0$ , and the brightest white at  $L^* = 100$ ; negative  $a^*$  values are for green and positive for red;  $b^*$  represent the proportion of yellowness and varies from blue (-) to yellow (+).

#### 4. Statistical analysis

The experiments were performed under statistical analysis by using SAS 9.0 (Institute Inc., 2002) and subjected to one-way analysis of variance (ANOVA) for a completely randomized design (CRD) statistical model. Means were compared by Least Significant Difference (LSD) method at a significance level of 0.05.

### Results

In this study, pure water was used to detect specific gravity of jujube fruits. Table 1 shows that the percentages of fruits cultivar 'Kaohsiung No.11', 'Jin-Tao' and 'Zhong-Yue' with specific gravity less than 1.00 are 99%, 98.4% and 90% respectively; and more than 1.00 are also 1%, 1.6% and 10% respectively. However, total soluble solids and firmness have not established a linear correlation. Neither have peel color ( $L^*$ ,  $a^*$  and  $b^*$  values) and total soluble solids (fig. 1, 2 and 3).

### Discussion

Yusof and Suhaila (1987) indicated that a decrease in specific gravity could be a reference for maturity sorting of fruit. This study found that Specific Gravity values of 99% of cv. 'Kaohsiung No. 11', 98.4% of 'Jin-Tao' and 90% of 'Zhong-Yue' were less than 1.00 at harvest time. It is very similar to those of Bhatia and Gupta (1985) who reported that specific gravity values at harvest maturity of 'Kaithli', 'Gola' and 'Umran' cultivars have been observed to be 0.88, 0.93 and 0.81 respectively. Moreover Meel *et al.* (1991) recommended that fruits of cultivar 'Sandhura Narnaul' should have a specific gravity less than 1 for harvest maturity. However, Tandom *et al.* (1989) found a continuous decrease in specific gravity of ripe fruits reaching values of less than 1.00 while fruits with values of greater than 1.02 were smaller and immature with poor color development. Then specific gravity of less than 1.00 of Taiwan jujube fruits might be the indicator of maturity stage.

However, the density of watermelon was found to be related to both the degree of hollowness and the soluble solids content which can be used as a measure of sweetness (Kato,

Table 1. Effects of specific gravity, firmness, total soluble solids (TSS), and skin color of 'Kaohsiung No.11', 'Jin-Tao', and 'Zhong-Yue' jujube fruit in 2015.

Cultivars	Firmness (N/cm <sup>2</sup> )		TSS (°Brix)		L*		a*		b*		% of fruits	
	<1 <sup>2</sup>	>1 <sup>3</sup>	<1	>1	<1	>1	<1	>1	<1	>1	<1	>1
Kaohsiung No.11 <sup>1</sup>	86.6	93.9	11.6	11.8	49.47	47.1	-9.66	-10.37	34.5	36.99	99	1
'Jin-Tao'	114.5	150.1	11.8	13.4	51.51	44.87	-10.57	-10.29	39.15	37.98	98.4	1.6
'Zhong-yue'	138.9	142.8	12.1	12.9	53.47	52.62	-9.78	-9.78	38.63	39.4	90	10

<sup>1</sup>Specific gravity <1: fruits are floating on pure water

<sup>2</sup>Specific gravity >1: fruits are sinking in pure water

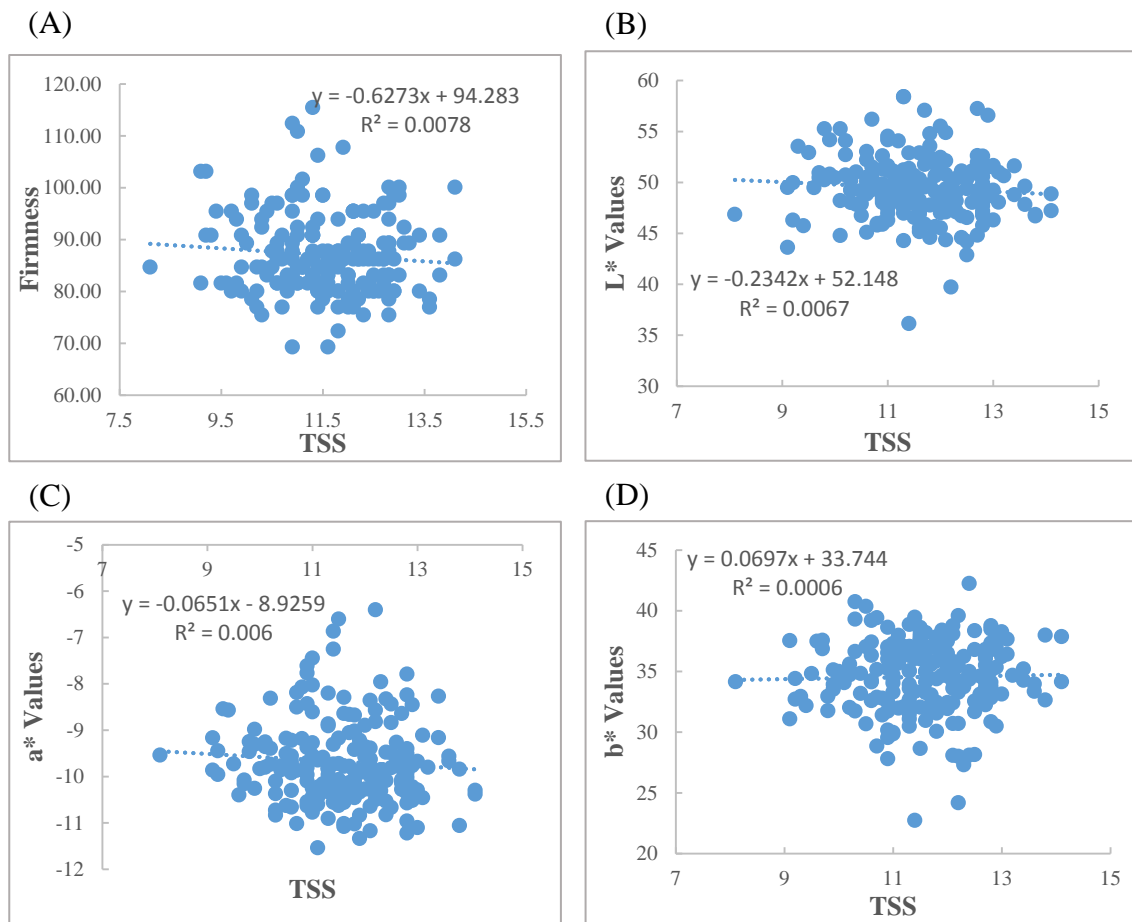


Fig. 1. Relationship between: (A) TSS and firmness; (B) TSS and L\* values; (C) TSS and a\* values; and (D) TSS and b\* values of 'Kaohsiung No. 11' jujube fruits which floated on pure water

1997). This study showed that there was no correlation between specific gravity and total soluble solids, or specific gravity and fruit firmness, or total soluble solids and fruit firmness. Neither was total soluble solids and peel color. It might be due to we had observed large variations in samples, making it difficult to sort fruits into maturity order with small differences in specific gravity. Therefore, this factor alone is not a good maturity index, but may be useful when it is used in conjunction with other fruit quality attributes.

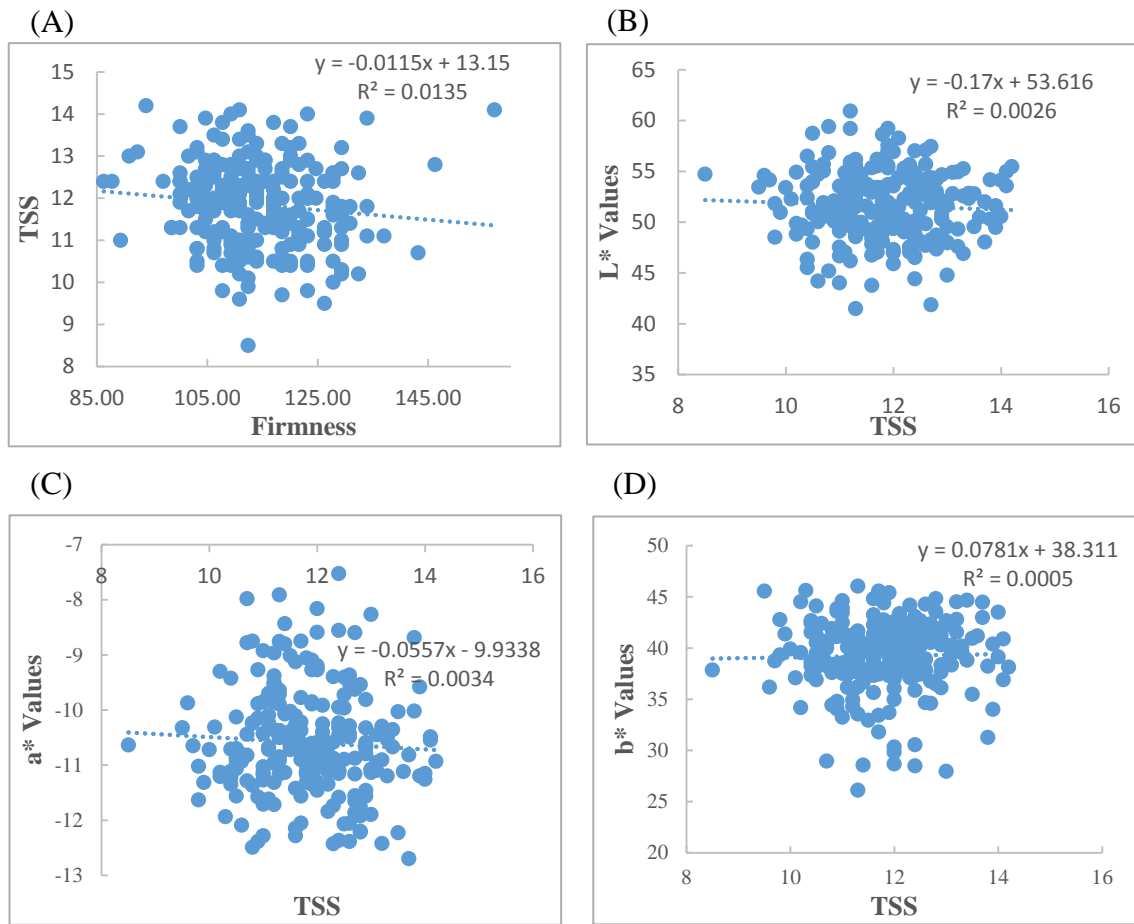


Fig. 2. Relationship between: (A) TSS and firmness; (B) TSS and L\* values; (C) TSS and a\* values; and (D) TSS and b\* values of 'Jin-Tao' jujube fruits which floated on pure water

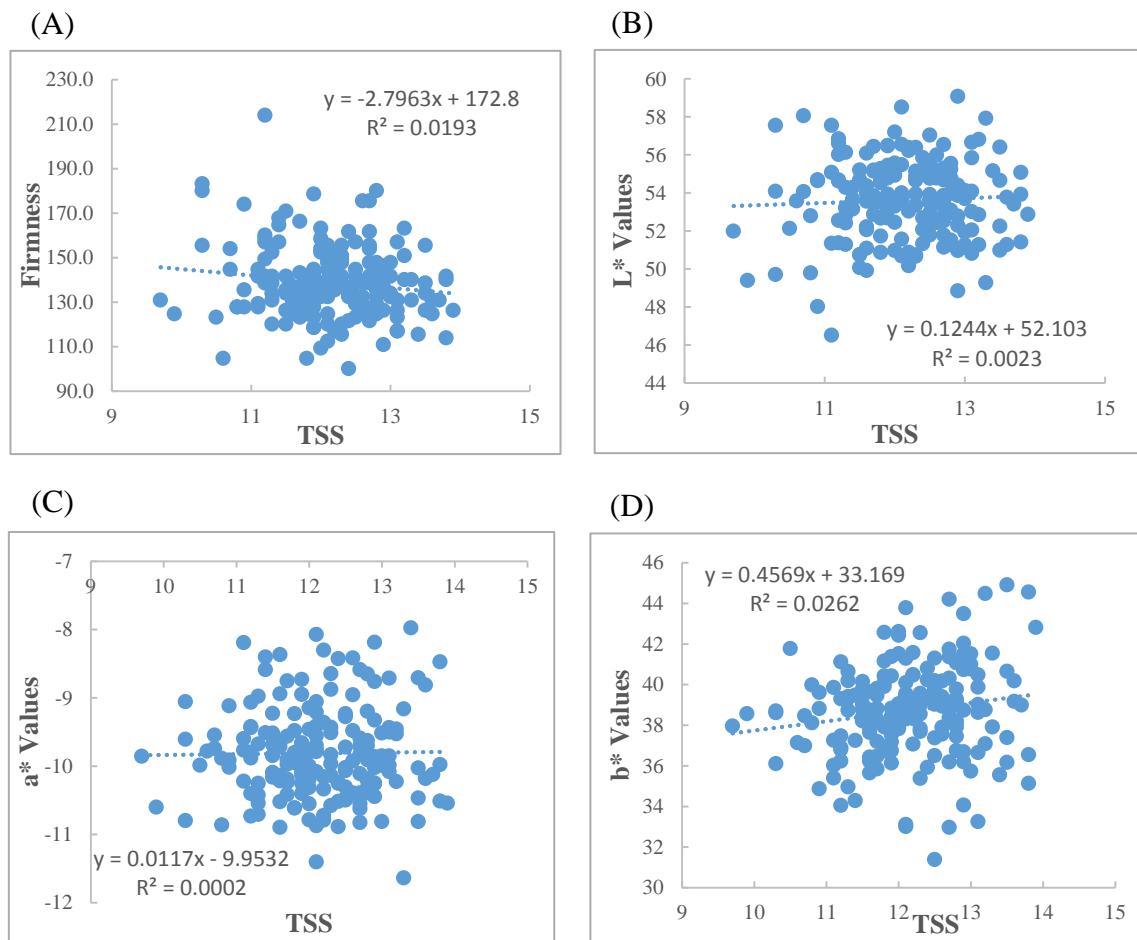


Fig. 3. Relationship between: (A) TSS and firmness; (B) TSS and L\* values; (C) TSS and a\* values; and (D) TSS and b\* values of 'Zhong-Yue' jujube fruits which floated on pure water

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## 比重作為台灣棗子(*Ziziphus mauritiana* Lamk.) 採收成熟度之判斷

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關鍵字: 成熟度、可溶性固形物、顏色質數

**摘要:** 本試驗結果顯示，比重調查結果顯示'高雄 11 號'、'金桃'及'中葉'果實比重小於 1 的比例分別為 99%、98.4%和 90%，而果實比重與可溶性固形物、硬度之間無顯著相關，果皮顏色與可溶性固形物間亦無明顯關係。總而言之，比重可能不適合當成採收成熟度之判斷之標。

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