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Physico-Chemical Changes of Lychee Fruit During Maturation

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ABSTRACT

Physico-chemical parameters of lychee fruits grown in Kagoshima Prefecture were examined. The principal free sugars in the flesh were sucrose, glucose and fructose. Order of the concentration was fructose＞sucrose＞glucose for immature fruits while glucose＞fructose＞sucrose for full-mature fruits. The predominant acid was malic acid (＞80 %) followed by citric and a very small amount of tartaric acid throughout the whole maturity stages. Decrease in the amount of organic acids and increase in sugars during fruit growth were observed as same as the case of mango fruits.

The correlation coefficients (r-value) were calculated for fruit firmness *vs.* °Brix (-0.66), titratable acidity (TA) (0.91), pH (-0.88) and °Brix / TA ratio (-0.70) in order to test whether physico - chemical quality of flesh can be predicted by measuring fruit firmness or not.

INTRODUCTION

Lychee (*Litchi chinensis* Sonn) is grown in many areas throughout the tropics. The fruits are borne in bunches on trees that may reach 9 to 12 m in height. The lychee is a unique type of fruit, having an aril as its edible, fleshy part. The fruit is round to oval in shape and measures 2.5 to 4 cm. Depending on the variety, the color of the pericarp (shell, skin) is bright red or rose-colored, with / without green color. The aril is the edible fleshy part with a white to creamy colored translucent pulp surrounding a glossy, brown seed. The flesh is grape-like, in texture, very succulent and aromatic, and is characterized by a sweet, acid taste[1]. Flavor deteriorates very quickly at room temperature and desiccation, with its accompanying loss of red color and developing of browning, can occur very rapidly.

The occurrence of browning renders the fruit difficult to sell and reduces its commercial importance[2]. In

the absence of maturity regulations, immature fruits are being sold on the commercial markets[3]. Therefore, assessment of lychee maturity is of major concern to the fruit market.

This report describes some of the physico-chemical changes during maturation in lychee fruits grown in Kagoshima Prefecture and regression analyses and correlation coefficients of fruit firmness *vs.* °Brix, titratable acidity (TA), pH and °Brix/ TA ratio.

MATERIALS AND METHODS

Materials

Lychee fruits were obtained from the orchard of Sata Town in southern part of Kagoshima Prefecture in July 1991. Tested fruits were picked from the one tree at three distinct stages of maturity : 1-fruits immature (green) ; 2-fruits half mature (red with partially green) ; and 3-fruits fully mature (red).Only undamaged fruits were used for chemical and physical analysis.

Averaging weights were immature 9.0 g, half mature 14.7 g, and full mature 18.3 g. Each mature stage consisted of 10 fruits.

Total soluble solids, pH and titratable acidity

Each fruit was separated into the component of skin, flesh and seed. Juice was prepared by crushing the flesh with handy juicer. Total soluble solids of juice were measured by means of ATAGO DIGITAL REFRACTOMETER PR-1 and were expressed as °Brix. Values for pH were determined using a pH meter (HORIBA F-12). Ten milliliters of 1/10 diluted juice were titrated with 1/100 N NaOH and the results expressed as titratable acidity (% malic acid).

Sugars

Fresh juice was mixed with 9 fold distilled water and the mixture clarified by centrifugation at 10,000× g for 10 min.The supernatant of each sample was pooled and filtered through Whatman No.1 paper, Shodex ED-13 0.45 μm microfilter. The samples were analyzed with a Jasco 880-PU model high pressure liquid chromatograph (HPLC) equipped with a Shodex RI SE-61 detector and a Shimadzu C-R6A data integrator. The HPLC conditions included a Shodex SUGAR SH1011P precolumn (6×50 mm), a Shodex SUGAR SH1011 column (8×300 mm), and eluent 0.01 N H_2SO_4, at 0.7 ml/min at 40 °C.

Organic acids

The same samples prepared for HPLC sugar analysis were used for HPLC organic acid analyses. The same system was used except that a Jasco 875-UV detector set at 210 nm, a Shodex Ionopak KC-810P precolumn (6×50 mm), a Shodex Ionopak KC-811 column (8×300mm) were used. Elution was conducted with 0.1 % H_3PO_4 at 0.7 ml/min at 40 °C.

Firmness

Firmness of the fruit was measured using a Multi Hardmeter KMH-51 (Kiya Manufacturing Co, Ltd.) with a cone shape probe. The force resistance against an external mechanical pressure was expressed as Kg.

Statistical analyses

Statistical analyses were conducted with a Stat View SE+Graphics software (Abacus Concepts, Inc., Berkeley, CA).

RESULTS AND DISCUSSION

Some physico-chemical parameters of lychee fruit were measured (Table 1). It is characterized by softening of the fruit body, a decrease in acidity, an increase in pH value, and an increase in °Brix as observed

Table 1. Changes in °Brix, TA, pH and firmness of lychee fruits during maturation.

Maturity stage	°Brix	TA	pH	Firmness
Immature	12.41±1.67	5.25±0.69	2.53±0.10	0.55±0.06
Half mature	14.90±1.03	1.04±0.17	3.58±0.11	0.30±0.06
Full mature	18.55±0.94	0.58±0.14	3.90±0.21	0.30±0.06

Each value represents mean ± standard deviation.

in other tropical fruits[4,5].

The principal free sugars present in the lychee fruit were sucrose, glucose and fructose. Order of the concentration was fructose>sucrose>glucose for immature fruits while glucose>fructose>sucrose for full-mature fruits. Content of sucrose and glucose gradually increased during fruit maturation while fructose content was steady(Fig. 1). This is different from the case of mango that glucose and fructose remain

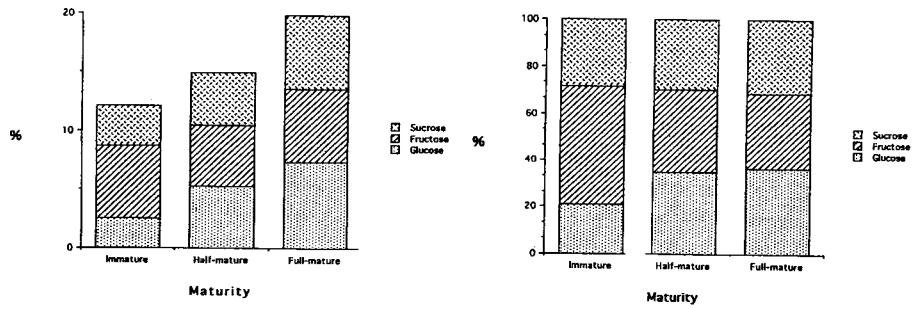

Fig.1. Changes in sugar content of lychee fruits during maturation. Left:values obtained through HPLC analyses ; right:relative amount of each sugar.

relatively steady while sucrose increases during ripening[4], and from the case of rambutan that each sugar gradually increased during fruit maturation[5].

Fig. 2 shows the relative amount of individual organic acids which contributes to the acidity in lychee fruits. The predominant acid was malic acid (>80 %) followed by citric and trace amount of tartaric acid throughout the three maturity stages. This is the reason the titratable acidity of lychee fruit is expressed in malic acid. On the whole, it was observed that malic and citric acids dramatically decreased during maturation. The difference between the amount of acid obtained by titration and HPLC analysis was observed,

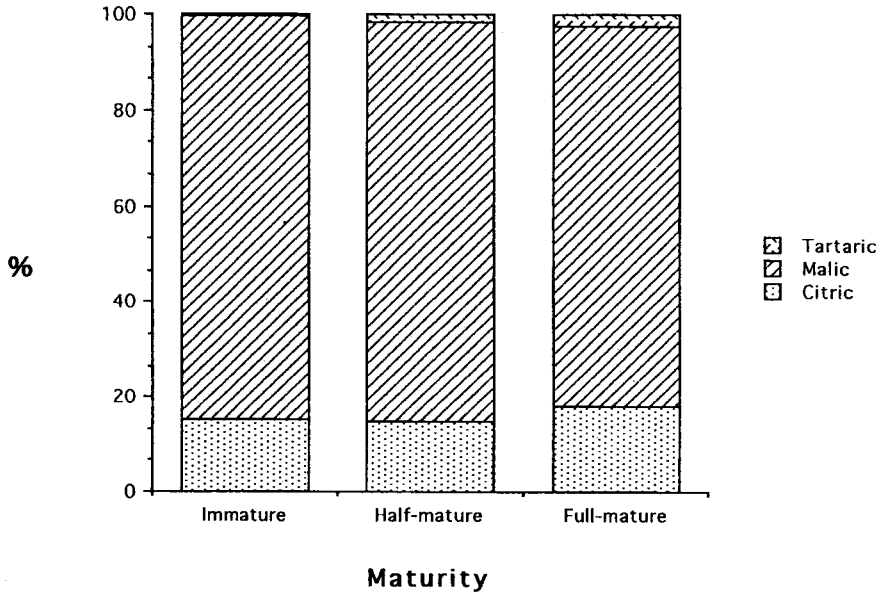

Fig.2. Changes in acid content of lychee fruits during maturation. Data are shown in relative amount of each acid obtained through HPLC analyses.

since a considerable proportion of acids may be present as salts (data are not shown). This phenomenon were also observed in case of soursop[6] and rambutan[5]. The dramatic decrease in the amount of organic acids and increase in sugars during fruit growth would contribute to the sweet taste in matured lychee fruits.

Since the values of fruit firmness decreased during maturation (Table 1), regression analyses on fruit firmness *vs.* °Brix, TA, pH and °Brix/ TA were conducted to test the hypothesis that these parameters can be easily predicted by fruit firmness with some degrees of certainty as well as skin color development. Fig. 3 shows the scattergrams and linear regression equations for these parameters. Correlation coefficients (r-value) for fruit firmness *vs.* °Brix, TA, pH and °Brix/ TA were -0.66, 0.91, -0.88, -0.70, respectively. These values were high, especially in TA value, therefore, they might indicate that the information for internal fruit quality parameters of acidity and sugar content in lychee can be predicted by measuring fruit firmness with certain degree of confidence. The sample size of this work was small, more research need to be conducted using larger sample size and cultivar.

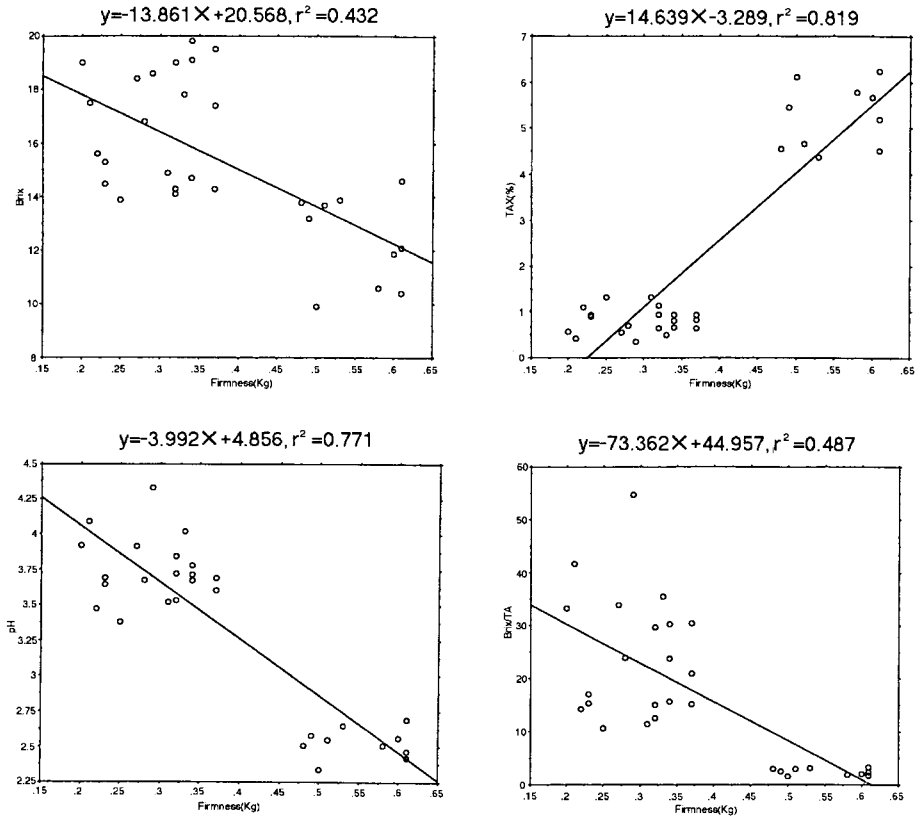

Fig.3. Scattergrams and linear regression equations for lychee fruit firmness *vs*. °Brix, TA, pH and °Brix/ TA ratio.

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