

VARIATIONS IN CHEMICAL COMPOSITIONS OF RIPE BANANAS (*MUSA SAPIENTUM* CV. BERANGAN) HARVESTED AT DIFFERENT STAGES OF MATURITY

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RINGKASAN

Satu kajian tentang perubahan kandungan kimia pulpa pisang Berangan masak yang dituai pada peringkat kematangan di antara lapan hingga 13 minggu selepas pengeluaran jantung telah dijalankan. Kekurangan kandungan kanji didapati amat ketara di antara lapan hingga 11 minggu dan selanjutnya menjadi malar. Di sebaliknya pula, jumlah kandungan gula bagi buah masak yang dituai di antara lapan hingga 11 minggu ketara meningkat dan menjadi malar selepas 11 minggu. Jumlah pepejal larut bagi buah masak yang dituai pada umur lapan hingga 11 minggu didapati meningkat. Bagaimanapun, nilai tersebut berubah-ubah pada minggu-minggu berikutnya. Peratus jumlah keasidan tertitrat dan nilai pH buah masak yang dipetik pada umur yang berlainan berubah mengikut aliran yang tertentu. Selain peringkat kematangan semasa penuaian, perbezaan sebahagian daripada kandungan kimia pulpa bagi sisir yang berlainan daripada tandan yang sama turut juga dikesan.

INTRODUCTION

In his recent review, MARRIOT (1980) covered a wide range of topics on the physiology and biochemistry of storage and ripening of banana. The review was extensively based on research reports from all over the world. Actually, banana has received much greater attention than any other tropical fruit crops due to its significant economic importance. In Malaysia, research on this aspect has gained greater interest and priority (CHOO and CHOON, 1972; CHOON and CHOO 1972; ABDULLAH, 1982; ABDULLAH, ROHAYA and ZAIPUN, 1985; BROUGHTON and WU, 1979; BROUGHTON, CHAN and KHO, 1978; LAM, AHMAD KAMARI and WAN RAHIMAH 1983).

Compositional changes in ripening banana were comprehensively reviewed by PALMER (1971). Some of the most common chemical components of ripened banana studied included carbohydrates, pectins, pigments, phenolic substances, acids, volatile substituents and proteins (MARRIOT, 1980). The conversion of starch, the major constituent of unripe bananas, to sugars during ripening was discussed by VON

LOESECKE (1950), whereas the presence of main organic acids, namely, malic, citric and oxalic has been reported by KAWABATA and SAWAYAMA (1974). Both compounds are highly associated with the taste quality of edible ripe fruits.

Despite the fact that a lot of research findings on bananas have been reported, literature on fruit quality after ripening in relation to maturity at harvest is scarce. In this context, studies on the chemical compositions which contribute to the quality of edible ripe banana is regarded as highly necessary. Some studies which had been carried out on the varying compositions of starch, total sugar, total soluble solids (TSS), total titrable acidity (TTA) and pH value in 'Berangan' banana are reported in this paper.

MATERIALS AND METHODS

Fruits

Eighty banana plants in a private farm at Sabak Bernam, Selangor were randomly tagged during flower emergence. Harvesting commenced after the eighth week. Four

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bunches of bananas which represented four replicates were harvested weekly until ripening took place (on the plant). The harvested fruits were immediately transported to the laboratory.

Sampling

The hands from each bunch were divided into upper, middle and lower portions. The upper portion refers to the bigger end of the cut stem of the bunch. Two fingers from the first, middle and last hands were taken randomly for chemical analyses of starch, total sugar, total soluble solids, pH and total titratable acidity. The analyses were replicated four times for each portion; each replicate represents a bunch.

Ripening

The fingers from each upper, middle and lower portion were dipped in 1 000 mg/l ethrel (Amchen Products, Inc., Pennsylvania, U.S.A.). The fruit were then left to ripen uniformly at 25°C until they reached the colour stage between 5 to 6 according to the ripening colour index as reported by LAM *et al.* (1983).

Determination of Starch and Total Sugar Contents

The pulp of two banana fingers was cut into small pieces and blended. The total sugar and starch contents were analysed according to AOAC (1970). The values are expressed as percent fresh weight.

Determination of Total Soluble Solids

Total soluble solids (TSS) were determined by a hand refractometer model HR-1A (Kyowa).

Determination of pH Value

Blended sample was mixed homogeneously with warm distilled water (60°C) in the ratio of 1:9 (w/v). After allowing to cool at room temperature, the mixture was

filtered. The pH of the filtrate was determined by using a Beckman pH meter.

Total Titratable Acidity

Total titratable acidity (TTA) was analysed in the same procedure as for pH analysis except that the mixture of pulp : water was in the ratio of 1 : 2 (w/v). Total titratable acidity was determined by titrating the mixture with standard 0.1N NaOH solution and expressed as percent citric acid.

RESULTS

Chemical Changes During Maturation

Starch

Generally, the starch content of banana pulp decreased continuously ($P < 0.01$) between the eighth and 11th week (*Figure 1*). For the upper and middle portions, the contents were not significantly different ($P > 0.05$) among fruit harvested between the 11th and 13th week. Starch content of fingers in the lower portion decreased

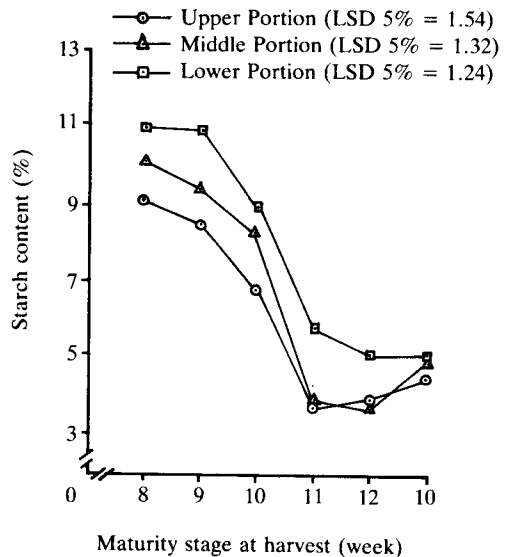


Figure 1. Starch content in the pulp of ripe Berangan banana harvested at different stages of maturity.

gradually until the 13th week. However, it decreased at a slower rate ($P>0.05$) between 11th and 13th week. The starch content of the ripen fruit from eight to ten weeks were always lower in the upper and the middle portions compared with the lower portion which had the highest starch content. However, the difference in starch content was not obvious in fruit of 11 to 13 weeks of maturity.

Total sugar

Figure 2 shows that the total sugar contents of fingers in all portions of the bunch increased significantly ($P>0.01$) from eight to 11 weeks. However, after 11 weeks, the contents were almost constant as no significant differences ($P<0.05$) were noted in ripe fruits until the 13th week. At the respective maturity stage, the total sugar content was always highest in the upper portion and lowest in the lower portion.

Total soluble solids

Generally, the TSS content of banana harvested between eight and ten weeks after

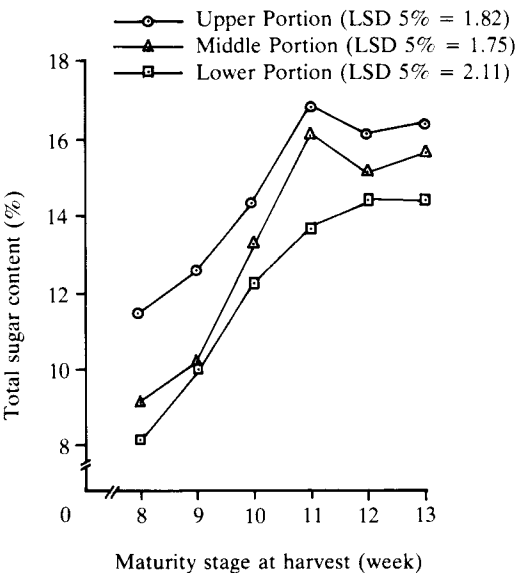


Figure 2. Total sugar content in the pulp of ripe *Berangan* banana harvested at different stages of maturity.

flower emergence increased significantly ($P<0.01$) (Figure 3). It was almost constant between the 11th to 12th week in fruits from the lower portion ($P>0.05$). However, the TSS values of the upper and middle portions fluctuated during this period; with a sudden drop at 13th and 12th week respectively ($P<0.05$). After the sudden reduction, the values were almost constant in both middle and lower portions as no significant differences were noted from then onwards ($P>0.05$). The variation in TSS content of each portion at the 13th week harvesting stage was not clear as shown by the presence of intersection points between curves.

pH

The pH values were found to be fluctuating but the differences between the respective harvesting stage were highly significant ($P>0.01$) (Figure 4). For all portions, the values increased in fruits harvested between the eighth to ninth week and the decreased sharply at the 10th week. An increase in pH was observed at 12th week followed by a decrease at the 13th week.

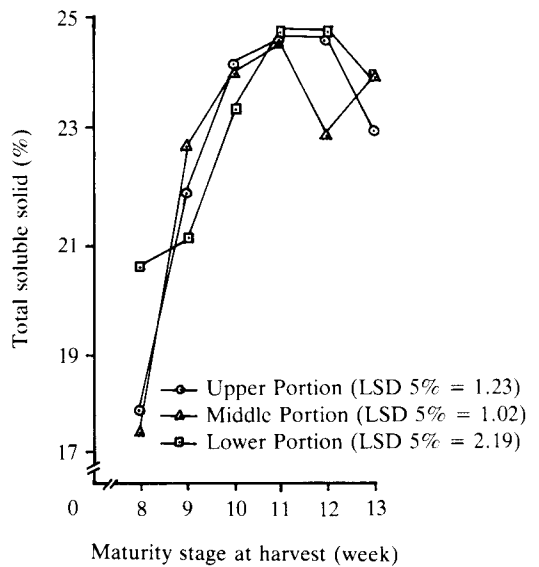


Figure 3. Total soluble solid content in the ripe pulp of *Berangan* banana harvested at different stages of maturity.

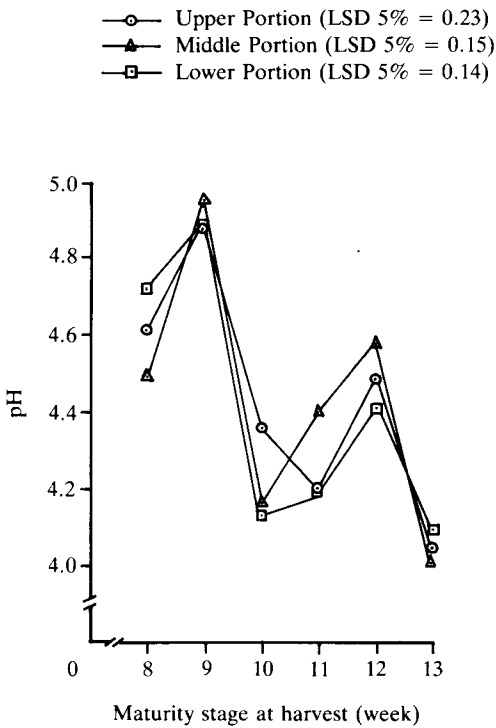


Figure 4. pH value in the pulp of ripe *Berangan* banana harvested at different stages of maturity.

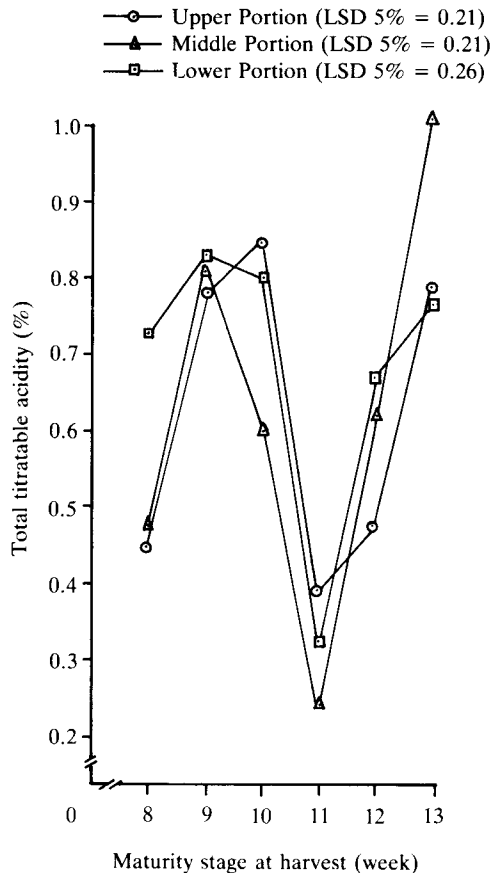


Figure 5. Total titratable acidity of ripe *Berangan* banana harvested at different stages of maturity.

Total titratable acidity

The fluctuations in TTA values of ripen banana pulp harvested between eight and 13 weeks followed a clear pattern in all portions (Figure 5). Generally, they increased between the eighth to ninth week although it was not significant ($P > 0.05$) in banana from the lower portion. The TTA values were at its lowest at the 11th week, then, increased drastically in all portions until the harvesting stage at the 13th week ($P < 0.01$).

DISCUSSION

The results obtained showed that the chemical compositions of ripen banana pulp varied with different stages of maturity at harvest although the same ripening development was achieved. The chemical variations were also observed among the fingers from different portions of the same bunch. In

another study, ABDULLAH, ZAIPUN and ROHAYA (1986) suggested the suitability of *Berangan* banana harvested between ten to 13 weeks after flower emergence. The ripen fruits harvested between the 12th and 13th week were found to be organoleptically acceptable and of the best quality. The variations in the chemical compositions of this cultivar at different maturity stages were also observed.

In this study, the starch and total sugar contents of ripen banana harvested at 11th–13th were not significantly different ($P > 0.05$). However, compared to the fruits of lower maturity at harvest, the starch content was significantly lower ($P < 0.01$), whereas the total sugar and TSS contents were significantly higher ($P < 0.01$). These

results were in agreement with SINGH, GANGWAR, SINGH and MOTIRAM (1976) who worked on 'Basrai' banana.

During ripening, starch is hydrolysed into sugars. However, the mechanism and enzymes involved are not well understood (PALMER, 1971). The accumulation of sugars and reduction in the starch content in five cultivars of local banana during ripening were reported by LAM *et al.* (1983). The contents of total sugar in 'Berangan' banana at colour stage 6 as reported by LAM *et al.* (1983), however, were much lower than that being reported in the paper.

The TSS contents of ripe 'Berangan' banana harvested at different maturity stages tend to follow the same trend as found in the total sugar contents. This is well understood as the TSS in the banana pulp comprised mainly sugars. The presence of sucrose, glucose and fructose as the major sugars in banana pulp was reported by VON LOESECKE (1950). The slight irregular pattern of TSS as compared to the total sugar contents is perhaps due to the involvement of other soluble compounds such as pectin. The soluble pectin of banana pulp increases during ripening (VON LOESECKE, 1950).

The acidity of the ripe banana pulp tends to vary if harvesting was carried out at different maturity stages. Taking the optimum maturity stage at 10 to 13 weeks as the basis for consideration (ABDULLAH *et*

al., 1986), the lowest TTA was obtained at 11th week followed by a significant increase in the following weeks. The highest pH value was obtained at 12 weeks. These results clearly indicate that the pH and TTA in the banana pulp are not possible for correlation. According to MARRIOT (1980), the major organic acids present in the banana pulp are malic, citric and oxalic. The variations in the composition of these acids during ripening might have influenced the pH and TTA of the fruit pulp.

Sweetness and sourness have been used as parameters in determining the organoleptic quality acceptance of fruits. If the degree of sweetness is taken into account, fruit harvested at 11–13 weeks would be more favourable due to the higher total sugar contents once they are ripened. However, when sourness is also included, harvesting at 13 week is less recommended due to the high level of acidity in the fruits after ripening.

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ABSTRACT

A study on the variation in chemical compositions of the pulp of ripen 'Berangan' banana harvested at maturity stages of eight to 13 weeks from emergence was carried out. The starch content decreased significantly between the eight to 11th week and remained constant from the onwards. On the other hand, there was a significant increase in total sugar content in ripen fruit harvested between eighth to 11th; the levels were constant after the 11th week. The increase in the percentage of total soluble solids was observed in ripen fruits of 8–11 weeks. However, the values fluctuated in the following weeks. The pH and the percentage of total titratable acidity of ripen fruits of different maturity stages change according to specific trends. Besides the maturity stages at harvest, variations in some chemical composition of the fruit pulp were also observed among the portion of hand from the same bunch.

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