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RESEARCH PAPER

Studies on Fruit Maturity Standards of Oil Palm in Andhra Pradesh under Irrigated Conditions

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ABSTRACT

In oil palm, correct maturity and grading plays a key role in achieving maximum oil recovery. Under ripe fruits have less oil content and in over ripe fruits the free fatty acid is high affecting the quality of oil. The present study was undertaken to evaluate different maturity stages of oil palm fruits in terms of color, oil content, carotene and moisture so as to develop suitable maturity standards. There are two types of bunches viz. Virescens and Nigrescens, based on the fruit color. In case of Virescens fruit type, there was a significant and correlation for fruit ripeness with carotene (r=0.87) and oil to wet mesocarp (r=0.82). The red color values showed increasing trend from 76.25 (unripe) to 142.22 (ripe). The Red/ Green ratio was 1 at unripe stage and increased with ripeness stage and reached 2 at ripe and over ripe stages. Similar trend was observed in Nigrescens and the red color showed an increasing trend from unripe stage (74.106) to ripe stage (123.73). In both fruit types, the moisture content was inversely related to ripeness.

Key words : Oil palm, maturity, color indices, carotene

INTRODUCTION

The maturity of oil palm fresh fruit bunches (FFB) at harvest is an important factor affecting quantity and quality of oil recovered. Over mature fruits drop from the bunch which incurs more labour for collection of the same. Further, the free fatty acid (FFA) content of over mature fruit tends to increase rapidly after harvest. In case of immature fruits, the oil content is less which in turn results in low oil extraction ratio (OER). Oo *et al*. (1986) revealed that 41.4 percent of mesocarp oil is accumulated between 16 and 20 weeks after pollination and another 18.9 % oil at later stages.

Although many factors are involved, correct maturity and grading plays a key role in achieving maximum OER. Presently, grading of FFB is not practiced in India and the price is fixed based on the OER reported by the factories without any method. On one hand, the quality of the bunches *per se* fetches no incentive for the farmer at present and on the other hand, the farmers do not bother to wait for complete maturity since there is not much difference between the weight of under ripe and ripe bunches. Manual grading, even if adopted, can be biased and the farmer may not be convinced of the price of the produce. Development of suitable maturity index can help to separate the FFB into distinct groups based on maturity and price fixing could be made on that basis. Hence a reliable system of maturity evaluation and grading forms the basis for optimizing the oil yield and quality as well as for price fixation of FFB.

Colour is an ideal maturity index which can be measured easily, non-destructively and is distinct at different levels of ripeness for many agricultural commodities. Standard colour chips are available for assessment of maturity of many commodities including peaches (Delwiche and Baumgardner, 1985) and colour charts are used to assess tomatoes (USDA, 1975 and McGlasson *et al*., 1986). Colorimeter showed potential for maturity assessment of tomatoes (Yang *et al*., 1987). The Malaysian Palm Oil Board suggested the possibility of using a colour meter for objective grading of oil palm FFB (Omar *et al*., 2003). Choong *et al.* (2006) reported that there is positive association between oil content and colour development in oil palm.

Liming and Yanchao (2010) reported 88.8% accuracy in grading of strawberry using color. A color based prediction model for maturity of Granny Smith apple was developed by Tijskens *et al.* (2010).

The present study was aimed at analyzing the changes in color and other bio chemical parameters of fruits at varying stages of ripeness and establishing their relationship to arrive at an objective maturity standard that can be measured non destructively.

MATERIALS AND METHODS

The experiment was conducted by harvesting bunches at varying stages of ripeness *viz.* unripe, under ripe, ripe and over ripe of tenera variety grown under irrigated conditions. Since the color patters are different for bunches of the common fruit types Nigrescens as well as the Virescens type, they were studied separately. Stages of ripeness were studied based the classification given by MPOB. The image of these bunches were captured (avoiding irregular colored portions) using digital camera (Olympus FE-280) and converted into three basic colors (RGB) and the intensity was recorded in terms of digital numbers. The intensity of each color was recorded by performing histogram analysis which counts the total number of pixels in each gray scale value and graphs it. Then, mean value of intensities found in the image or selected regions in the image will be used for the study. Laboratory analysis were carried out simultaneously to determine the change in carotene content (Malaysian Palm Oil Board method), oil content by using Soxhlet apparatus on wet as well as dry weight basis and moisture content at each stage of ripeness.

RESULTS AND DISCUSSION

The results of the study are presented hereunder separately for Nigrescens and Virescens fruit types.

Change in carotene content in Virescens

The results of the study indicated that the carotene content which is mainly responsible for the orange red color of fruits increased during the process of ripening. Significant difference was observed in the carotene content of fruits at different stages of ripeness (Fig.1). The mean carotene content of fruits was 29.2 ppm for unripe fruits and increased to 202.3 ppm at under ripe stage and 519.9 ppm during ripe stage. The carotene content of overripe fruits was 496.0 ppm. The carotene content (Fig. 1) was correlated positively with stage of ripeness (0.87). This could be attributed to the formation of carotenoid pigments as evident from analysis of fruits.

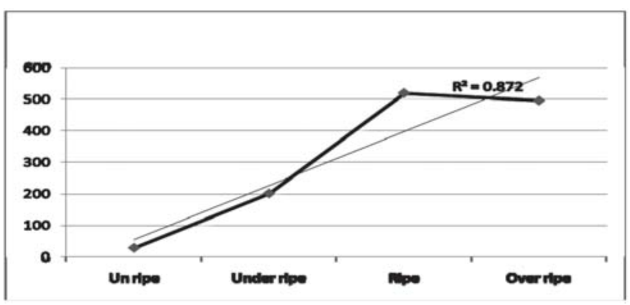

Fig. 1: Variation in Carotene content of Virescens fruit type with ripeness

With respect to oil content on wet mesocarp significant difference was observed for almost all ripeness stages except for the over ripe fruits (Fig. 2). The unripe fruits had less oil content (8.78%) and it gradually increased to 48.73% at ripe stage. However, there was no significant difference between the oil content of ripe and over ripe bunches. Oil percentage on dry mesocarp showed similar trend as that of oil percent on wet basis. With regard to the oil content, the correlation was highly significant and positive wet mesocarp (0.882) and dry mesocarp (0.751). The moisture at unripe stage (73.52%) was significantly different from the moisture at the other three stages studied. However, the change in moisture content between ripe (32.19%) and over ripe stage (32.78%) was statistically insignificant.

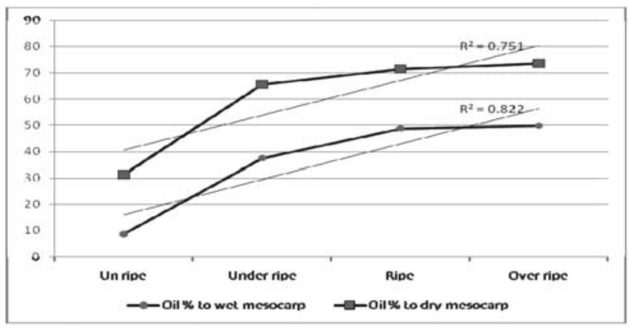

Fig. 2: Change in oil content in Virescens fruit types with ripeness

Changes in RGB colour values in Virescens

The red colour value was 76.25 at unripe stage and showed an increasing trend up to over ripe stage (159.27). The red colour values of unripe fruits were significantly different from other stages of ripening (Table 1). At under ripe stage, red colour was significantly different from unripe as well as over ripe fruits. The green colour at under ripe stage and ripe stage was significantly different and the values ranged from 74.65 (unripe), 86.796 (under ripe), 69.48 (ripe) and 78.31 (over ripe). However, there was no clear trend in the change of green colour values with stages of ripeness. There

Table 1: Change in RGB values with ripeness stage

Ripeness stage	Red	Green	Blue	R/G ratio
Un ripe	76.24	74.65	57.97	1.01
Under ripe	132.20	86.79	44.35	1.56
Ripe	142.22	69.48	36.54	2.08
Over ripe	159.27	78.31	39.25	2.09
F value	*	*	*	*

*Significant at 0.05 level

was significant difference between blue colour values at various stages of ripeness which ranged from 57.97 at unripe, 44.35 at under ripe, 36.54 at ripe and 39.259 at over ripe stages.

To arrive at a dependable criteria of distinguishing bunches of optimum ripeness, the direct and inverse ratio of red and green color was worked out. The ratio was 1.01 during the unripe stage which increased gradually and reached 2 and above once the fruits reached proper ripeness. So these differential ratios derived from the color values could be taken as the index for deciding correct ripeness stage. Although the ratio remained around 2 even for over ripened bunches, the number of fruits detached will give sufficient indication of the later.

Changes in carotene content Fruit type : Nigrescens

Significant variation was observed in the carotene content of fruit from unripe to over ripe stage (Fig. 3). Mean carotene content was 16.07 ppm at unripe stage which increased to 95.86 ppm at under ripe, 346.87 ppm at ripe and 506.01 ppm at over ripe stage.

Oil percent on dry mesocarp was only 24.69% during unripe stage (Fig. 4). It increased to 65% during ripe stage and 73.47% during over ripe stage. At unripe stage the oil to wet mesocarp was 6.44% which

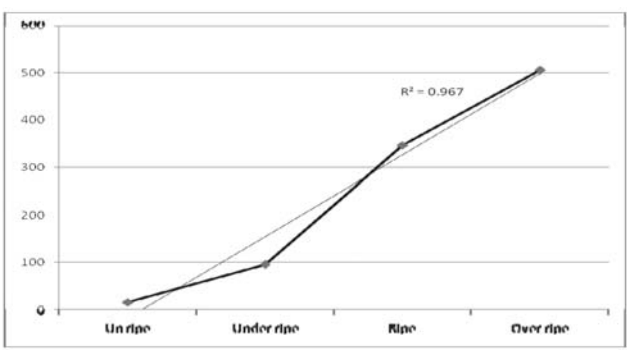

Fig. 3: Change in carotene content of Nigrescens fruit type with ripeness

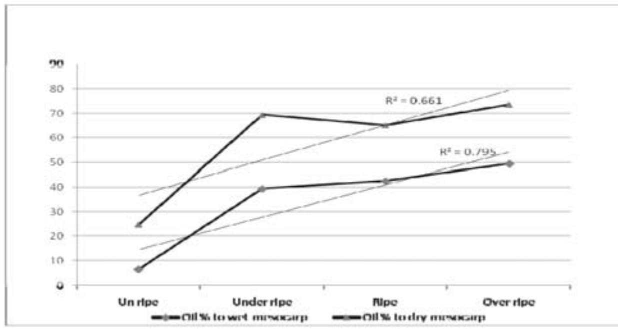

Fig. 4: Change in oil % in Nigrescens fruit type with ripeness stage

increased to 39.35% during under ripe stage, 42.47% at ripe stage and 49.48% during over ripe stage. The change in oil content between ripe and over ripe stage could be due to change in moisture level rather than oil level itself. The initial moisture content of 76.11% in the mesocarp gradually decreased to 40.93% during under ripe stage 37.63% at ripe stage and 32.65% at over ripe stage.

Changes in colour values in Nigrescens

Values obtained for RGB color showed significant difference with ripeness stage (Table 2). Red colour values increased from 74.10 at unripe stage to 122.44 at over ripe stage. The colour change between ripe and over ripe stage was not significant. Green colour values showed slight increase with ripeness. With respect to blue colour, a clear trend could not be observed. The R/G ratio was 1.14 at unripe stage which increased to 1.5 at under ripe stage.

The results of the image analysis revealed that there is strong correlation between stage of ripeness and color values in oil palm FFB. The maximum correlation of red color with ripeness indicate the suitability of the same for distinguishing fruits into different ripeness classes. The carotene content (which imparted the typical orange red color to fruits) was directly correlated to oil content up to optimum ripeness

Table 2: Change in RGB values with ripeness stage

Ripeness stage	Red	Green	Blue	R/G
Un ripe	74.10	65.08	62.98	1.14
Under ripe	109.28	72.84	56.95	1.50
Ripe	123.73	79.48	72.77	1.56
Over ripe	122.44	82.72	78.34	1.50
F value	**	**	**	**

** significant at 0.01 level

stage. An electronic device (*viz.* color reader) could be developed by incorporating the standard color values or the differential ratio of colors for use as an oil palm FFB grading instrument.

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