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COLOUR METER FOR MEASURING FRUIT RIPENESS

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At present, fresh fruit bunch (FFB) grading is done visually by quality control conductors at estates and by graders at purchasing centres and mills. The most critical process in FFB grading is to categorize the bunches into ripe, under ripe and unripe. The MPOB manual on FFB grading defines a ripe bunch when the mesocarp colour is reddish orange and the bunch has 10 or more empty sockets of detached fruitlets; an under ripe bunch has yellowish orange with less than 10 empty sockets; and an unripe bunch has yellow mesocarp with no empty sockets (MPOB, 1995).

The human eyes perceive colours differently and this very often lead to dispute between graders and sellers. Therefore, a standard colour meter to measure fruit ripeness will provide a consistent FFB grading.

A number of colour meters are available in the market and some of the models are suitable for fruit ripeness measurement. In this research, a fairly simple to operate and easily available colour meter was used.

UNDERLYING PRINCIPLES

The change in the mesocarp colour is due to the accumulation of the carotene pigments, which also corresponds to the oil content of the mesocarp when analysed.

The colour variation of the mesocarp was captured electronically and converted into numerical values using a standard colour model shown graphically in *Figure 1.* Since each colour is represented by three values, a colour difference method was adopted (Ashhar *et al.,* 2000). At the same time, the fruit sample was analysed for its corresponding oil content. The colour of the fruit sample with the highest oil content from ripe bunch was chosen as a reference value. The differences between reference value and the sample value indicated the stage of fruit ripeness.

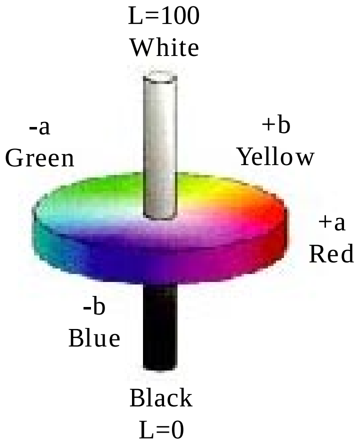

*Figure 1. Standard L*a*b* colour model.*

METHODOLOGY

Experiment 1

Fifty FFB samples *(tenera)* at various stages of ripening were selected. Three outer fruitlets, each from top, middle and bottom was sliced with a pen knife to expose a flat surface of the mesocarp. The average colour value of the mesocarp was then recorded using a colour meter. The fruit samples were analysed for their oil to wet mesocarp using the soxhlet method.

From the colour values and the bunch analysis results, sample with highest oil content was chosen as a reference colour value. Other colour values for the rest of the samples were calculated. A graph between mesocarp colour difference and oil to wet mesocarp was plotted and polynomial regression analysis was carried out. This standard reference colour value was set into the colour meter and used in following experiments.

Experiment 2

The objective of this experiment was to test the colour meter reading against human graders to determine whether they agree with the grade read by the colour meter. The first test was conducted at Muar Oil Palm Mill with one group of graders and the number of bunches sampled was 72. The second test was conducted at Rantau Oil Palm Mill with two groups of graders and the number of bunches sampled was 100. At both locations, the colour meter and human group categorized the FFB into ripe, under ripe and unripe category similar to FFB grading process. The data between graders and the colour meter were first compared to see the degree of similarity, as this will suggest whether the meter is reliable. The data were then examined in relation to ripeness categories. Finally, chi-square test was conducted to see if there was any significant difference between the two methods of ripeness measurements.

RESULTS AND DISCUSSIONS

Experiment 1

A second order polynomial regression analysis shows a strong correlation between mesocarp oil content and colour values ($R^2 = 0.82$). A ripe fruit contains a maximum amount of oil in the mesocarp indicated by a plateau on the graph. Colour value at this point was taken to differentiate between ripe and under ripe fruit. However, there is no standard oil content to indicate under ripe and unripe bunches. To differentiate between the two categories, colour values closest to under ripe and unripe bunches graded by reputable grader was taken. These values were taken as standard for the colour meter and used in the verification process.

Experiment 2

The test results carried out at Muar Oil Palm Mill and Rantau Oil Palm Mill are shown in *Table 1*.

TABLE 1. COLOUR METER GRADING AGAINST HUMAN GRADER AT MUAR OIL PALM MILL AND RANTAU OIL PALM MILL

	Muar OP Mill		Rantau OP Mill			
	Grader		Grader 1		Grader 2	
Observation	Nos.	%	Nos.	%	Nos.	%
Human grader agreed with colour meter	51	70	74	74	87	87
Human grader did not agree with colour meter	21	30	26	26	13	13
Total	72	100	100	100	100	100

Data from Muar Oil Palm Mill showed that 70% of the ripeness categories produced by the colour meter were agreed upon by grades. Similar results were produced at the Rantau Oil Palm Mill. The results of these trials suggest that the colour meter could be used to determine ripeness.

Table 2 shows the cross tabulation frequency data between colour meter and grader at Muar and Rantau Oil Palm Mills.

TABLE 2. DISTRIBUTION OF RIPE, UNDER RIPE AND UNRIPE CATEGORY BETWEEN COLOUR METER AND HUMAN GRADER AT MUAR AND RANTAU OIL PALM MILL

Ripe category	Muar Oil Palm Mill		Rantau Oil Palm Mill		
	Colour meter	Grader	Colour meter	Grader 1	Grader 2
Ripe	24	24	65	65	59
Under ripe	28	36	29	22	34
Unripe	20	12	6	13	7
Total	72	72	100	100	100
Chi-square	3.000	-	6.253	-	-
DF	4	-	4	-	-
P value	0.392 (not significant)	-	0.181 (not significant)	-	-

At the Muar Oil Palm Mill, the number of ripe bunches recorded by colour meter and grader were the same (24), while the under ripe bunches were 28 and 36 respectively. The unripe bunches were 20 and 12 respectively. The chi-square analysis showed a P value of 0.392, which is not significant. This suggests that there was no significant difference in the distribution of ripeness categories between the colour meter and the grader. This implies that the colour meter can be used to determine ripeness.

Similarly, at the Rantau Oil Palm Mill, the number of ripe bunches recorded by colour meter and grader 1 and grader 2 were 65, 65, and 59, while the under ripe bunches were 29, 22 and 34 respectively. The unripe bunches were 6, 13 and 7 respectively. The chi-square analysis showed a P value of 0.181, which is not significant. These results support those obtained from the earlier mill.

CONCLUSION AND RECOMMENDATION

From the trials, it is concluded that with an appropriate technique, a colour meter could be used to measure fruit ripeness, which at present is being carried out visually by human graders. The trials had shown that there was no significant difference in fruit ripeness between using the colour meter and the human grader. Furthermore, colour meter may give consistent results compared to human grader as the latter can be biased.

Figure 2. Instrument used in the experiment.

Figure 3. Measuring fruit ripeness in operation.

Figure 4. Sample of colour meter available in the market.

The technique and method that have been developed can be transferred to instrument manufacturer so that the existing meter could be reconfigured to suit the present oil palm grading procedures or any interested party for the development of FFB grading meter. When such instrument is already available, MPOB may insist FFB dealers, mills and estates to use a FFB grading meter whenever dispute arises in determining fruit ripeness or when the seller loses faith in human grader.

REFERENCES

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