Journal of Agricultural and Food Engineering 1 (2020) 0004
Journal homepage: www.myjafe.com
DOI: http://doi.org/10.37865/jafe.2020.0004
e-ISSN: 2716-6236

Research Article

Colour evaluation of sterilized and unsterilized palm fruitlets mesocarp at different storage time

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ARTICLE HISTORY

Received: 2 March 2020
Received in revised form: 9 March 2020
Accepted: 10 March 2020
Available Online: 12 March 2020

Keywords
Oil palm
Mesocarp
Colour
Storage time
Oxidation

Abstract

Colour has been widely used in agriculture application in order to indicate the different level of ripeness and freshness of fruits and food. In this study, the freshness of oil palm fruitlet was evaluated by measuring its colour using colorimeter. Two types of oil palm fruitlets were investigated; sterilized and unsterilized, and the fruitlets were exposed to the environment for three days. The measurement of colour (in terms of L*, a*, and b* values) was measured using Konica Colour Reader on an exposed surface that was cut to specific dimension. The individual parameters of L*, a*, b* colour systems were measured daily for three days. The findings revealed that the unsterilized fruitlet showed the most significant color change after three days which indicates that oxidation and deterioration of the freshness continues to occur. The sterilized fruitlet did not show any major difference of colour value which can be explained by the inhibition of enzyme activity by sterilization process that causes oxidation. This study has proven that colour can be used to evaluate the freshness and oxidation of oil palm fruitlets. The findings of this study will be useful for palm oil industry to develop a proper palm freshness evaluation system.

1. Introduction

Freshness and ripeness of palm oil fresh fruit bunches (FFB) are very important for palm oil mill in order to produce high quality of palm oil. Currently, the freshness of FFB is determined physically by observing its bunch stalk wetness and colour. However, this method is subjective and inconsistent because it based on the skill and experience of the grader itself. Hence, it will affect the mill oil extraction rate (OER) and also the quality of oil produced. Thus, a proper system of freshness evaluation during grading is critically needed to maximize the oil yield at the same time to produce high quality oil.

Colour has been widely used in agriculture application in order to indicate the different level of ripeness and freshness of fruits and food. Many researchers reported about the change in colour value in fruits (Ishak & Hudzari, 2010; Krishnan, Sofiah, & Radzi, 2009; McCaig, 2002; Wu & Sun, 2013). Colour systems like RGB and CIE Lab are some of the most popular usually used because it is easy. May & Amaran (2011) used RGB colour model to develop new model of automated grading system for oil palm with accuracy of 86.64 %. Balasundram, Robert, & Mulla (2006) investigated the relationship between oil content in oil palm fruits and its surface colour distribution by using camera vision. Omar, Khalid, Harun, & Wahid (2003) have found a strong correlation between colour value and mesocarp oil content. Colorimeter showed potential for maturity assessment in oil palm. MPOB indicate the possibility by using colour meter oil palm FFB assessment. The aim of this study is to determine the colour change at different sterilized and unsterilized oil palm fruitlet mesocarp during storage at room temperature.

2. Materials and methods

2.1 Preparation of sample

Ripe oil palm fresh fruit bunches (FFB) from *Tenera* variety were collected from Universiti Putra Malaysia's oil palm estate. The bunch varying in weight from 10-20 kg was chopped manually with an axe to facilitate the fruitlets stripping by hand. Some fruitlets without bruising varying in weight 8 to 20 gram were selected. Then, the samples were subjected to sterilization process at temperature 135 °C for a period of 90 minutes using Autoclave B-150, (Systec, Germany). Next, both fresh and sterilized palm fruitlets outer skin were cut square with dimension 1 cm X 1 cm to make its mesocarp appears shown in Figure 1. The sample was kept at room temperature for day 1, day 2, and day 3 of storage time.

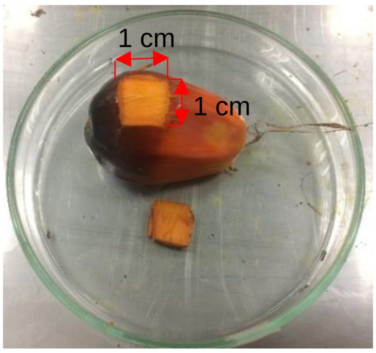

Figure 1. Palm fruitlets outer skin were cut square with dimension 1 cm × 1 cm for colour measurement

2.2 Colour measurement

Both fresh and sterilized palm fruitlets mesocarp colour were measured by using Konica Minolta colour reader (model CR-10, Japan) in a controlled environment. The colour values were recorded as L*, a*, b*. The instrument was placed directly

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Table 1. Analysis of variance for storage time and the treatment condition on L*, a*, and b* colour values

Source	L*			a*			b*		
	df	F value	p-value	df	F value	p-value	df	F value	p-value
Model	5	27.658	0.000	5	87.485	0.000	5	35.845	0.000
A:Treatment	1	130.734	0.000	1	393.673	0.000	1	165.802	0.000
B: Time	2	3.351	0.039	2	12.527	0.000	2	5.620	0.005
A × B	2	0.654	0.654	2	9.349	0.000	2	1.092	0.339
Error	114			114			114		
Total	120			120			120		

Table 2. Mean L*, a*, and b* colour values for different heat treatment with storage time

Heat Treatment	Storage time	N	L*	a *	b*
Fresh	Day 1	20	26.7100±0.044^{a}	36.1400 ±0.057^{a}	14.5650±0.166^{b}
	Day 2	20	26.4000 ±0.091^{b}	35.4600±0.030^{b}	13.3550±0.135^{b}
	Day 3	20	25.8100±0.033^{c}	34.4350±0.085^{c}	12.5600±0.167^{c}
Sterilized	Day 1	20	23.9800±0.086^{b}	31.8900±0.027^{b}	10.0350±0.112^{b}
	Day 2	20	23.9650 ±0.017^{b}	31.6900±0.027^{b}	10.0350±0.053^{b}
	Day 3	20	23.5650±0.056^{b}	31.2350±0.025^{b}	9.8750±0.080^{c}

The means with the same letter are not significant difference at (P ≤ 0.05).

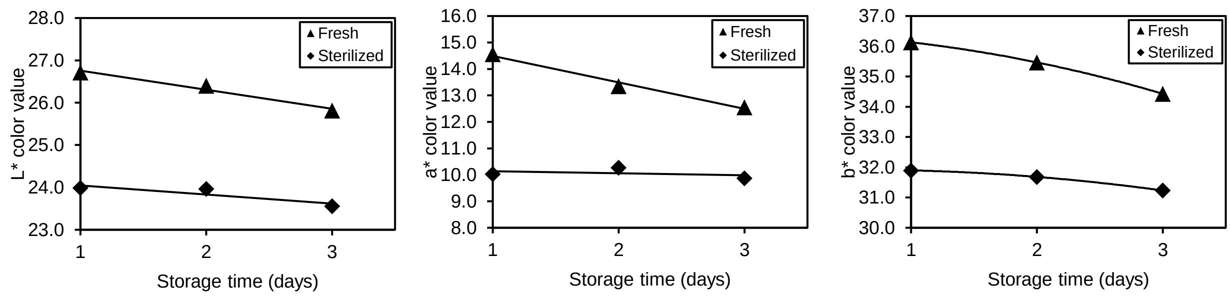

Figure 2. Relationship between storage time and the L*, a*, b* colour values for fresh and sterilized fruitlets

in contact with the fruitlets mesocarp to avoid any light leakage from the light emitted by the colorimeter.

2.3 Statistical analysis

The statistical analysis was carried out by using SPSS software. The results were expressed as the mean. Data were analyzed using two-way analysis of variance (ANOVA). The confidence limit based on 95 % (P<0.05) were conducted to determine mean significance different between the fresh and sterilized fruitlets colour.

3. Results and discussions

In order to detect significant difference from the data collected, a statistical analysis of variance for the effect of treatment condition and storage time on L*, a*, b* colour values were performed by using SPSS software. This test was run to identify if the independent variables (treatment condition and storage time) will interact with the dependent variable (L*, a*, b* colour value). Table 1 shows the computation of ANOVA for two factors A and B which represent the storage time (day 1, 2 and 3) and the treatment conditions (fresh and sterilized fruitlets), respectively. The effect of heat treatment on the L*, a*, b* colour values was highly significant. The effect of storage time also shows a significant result to the L*, a*, b* colour values. This analysis reflected that L*, a*, b* colour values were affected directly by heat treatment and storage time, respectively.

The pairwise comparison was used to test the different possibility affected by the type of heat treatment and storage time to the colour values. Table 2 shows the mean colour values in both fresh and sterilized mesocarp during day 1, 2, and 3. For fresh fruitlets, there were significant difference in the L*, a*, and b* values from day 1 to day 2, and from day 2 to day 3, respectively. However, for sterilized fruitlets, there was no significant difference in the L* and a* values from day 1 to day 2, and from day 2 to day 3. Only b* value from day 2 to day 3 shows significant difference for sterilized fruitlets. On top of that, it was also observed that as the fruitlets undergoes sterilization treatment, it will result in lower of L*, a*, and b* colour values compared to fresh fruitlets. The low colour value is caused by the chemical change during sterilization process. Maillard browning reactions are believed to be source of colour development due to breakdown of sugar content during sterilization (Brands & van Boekel, 2001).

The changes in L*, a*, and b* values for both fresh and sterilized condition with different storage time are given in Figure 2. From the Figure 2, it could be noticed that all the three colour values were decreasing as the storage time extended. This may be due to the oxidation process, where enzyme react with oxygen results in biochemical conversion of plant phenolic compounds to brown pigments. Fresh fruitlets colour values decreased rapidly than the sterilized fruit. The degradation of colour values for fresh fruitlets was caused because of the lipase enzyme activity and storage time. It has been reported that oil palm need to be sterilized immediately after harvest to deactivate enzyme activity (Hadi, Ahmad, & Akande, 2009).

Figure 3 illustrates the overall colour difference along storage time for CIE L*, a*, and b* colour values. The increasing trend for total colour change value shows increment of value throughout the storage time. Fresh fruitlets show a drastic colour difference from day 1 until day 3 compared to the sterilized fruitlets. Palm mesocarp is one of the plant tissues which contains the highest amount of lipase. Sterilization process inactivated lipase activity; thus, the fruitlets do not undergo any oxidation (Ngando Ebongue, Dhouib, Carrière, Amvam Zollo, & Arondel, 2006).

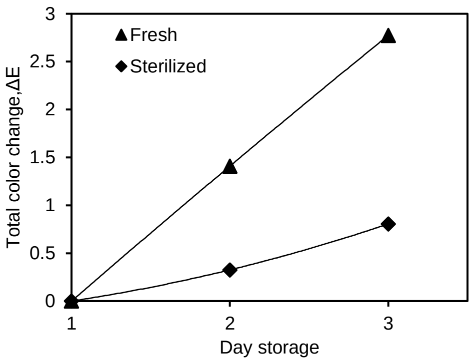

Figure 3. Relationship between storage time and total colour change for fresh and sterilized fruitlets

4. Conclusion

The overall results for fresh and sterilized CIE Lab colour values of the oil palm fruit mesocarp indicated that the colour value decreased as the storage time increased. It can also be concluded that the freshness of fruitlet within day 1, 2, and 3 affecting the colour changes values. It showed that as the palm fruitlets freshness degraded, the colour value decreased. The colour value changed for sterilized fruitlets mesocarp is minimal compared to unsterilized fruitlets, thus it apprehending that the sterilization process had altered the chemical composition of the fruit that inhibited the oxidation activity. The results of the study will be useful in palm oil industry specifically to develop a prediction model for freshness evaluation during grading based on the CIE Lab colour system.

Author contributions

Mohd Hafizz Wondi: Conceptualization, Methodology, Data curation and Writing- Original draft preparation. Rosnah Shamsudin: Supervision and Project administration. Robiah Yunus: Supervision, Resources, Writing- Reviewing and Editing. Nur Izzah Nabilah Haris: Reviewing and Editing final manuscript.

Conflict of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This work was supported by Ministry of Energy, Science, Technology, Environmental & Climate Change (MESTECC), Malaysia through Smart Challenge Fund (SMART FUND) (Reference No: UPM/800-3/10/5450824).

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