HOM THONG BANANA RIPENING COLOR SCALE FOR INDIVIDUAL PACKAGING SELECTION IN THE RETAIL MARKET

Manenuch Wipaweeponkun[1] and Jeeranuch Buddeejeen[2*]

9/9 Moo.9 Bang Phut, Pak Kret, Nonthaburi, 11120
[1]Division of Industrial Technology, School of Science and Technology,
Sukhothai Thammathirat Open University
[2]Division of Industrial Technology, School of Science and Technology,
Sukhothai Thammathirat Open University

*Corresponding author: Jeeranuch Buddeejeen, e-mail jeeranuch.bud@stou.ac.th

ABSTRACT

The objective of this research is to investigate the appropriate design selection of individual packaging with material type, packaging size, the percentage of permeability for gases and water vapor (% Open air hole) by measuring Hom Thong banana ripening color scale from green to yellow color. The methodology of this research is to select a banana color scale for consumption to adapt from the CSRIO standard by using the spectrometer color measurement. The consumer's preference split from 0% to 100% by calculating the percentage of the banana ripening area. The boundaries of the area divided into five slots and the level in each slot have three scales. The result of this research found that the color of Hom Thong bananas for the retail market can be divided into banana ripening color scales from green color with the average value of u'0.1836 and v'0.5403 to yellow color with the average value of u'0.213 and v'0.538. The nine color scales set for classification which is the appropriate design selection of individual packaging to keep Hom Thong banana for the long life of storage. The comparison between the material type of packaging, it found that Polyethylene and Polypropylene material does not differ of the percentage of banana ripening color scale. The packaging size the effect, the result found that small size (14 x30 cm.) can keep a long life of storage than big size (20x30 cm.). The comparison between closed seal packaging and opening air hole packaging has different significantly in banana ripening color scale. The suitable permeability for gases and water vapor at 0.3-1% can reach to desired banana respiration rate and keep long life of storage than closed seal packaging. The contribution of this research can expand to agricultural farmers to apply the appropriate packaging for Hom Thong banana in the retail market.

INTRODUCTION

Hom Thong Banana (*Musa acuminata* AAA Group 'Gross Michel') is a significant economic fruit of domestic consumption and export to foreign countries, especially in China and Japan. Both domestic and foreign markets demand it. According to the Department of International Trade Promotion reported by Pisanwanich, A.[1] that shows The statistic of Hom Thong Banana for export about 171,000 tons. In the domestic market, Hom Thong banana is expanding from the fresh market to convenient stores and modern trade. The packed size for retail market is to pack for individual pack one piece/bag and 4-2pieces bag and fit for consumers. The banana is popular with many groups of consumers from youth, adult, and elderly groups. The main problem of Hom Thong Banana is the short life of storage and sensitive products for transportation. So there is a considerable loss only 5-7 days after harvest. This period is shorter than fruits with low respiratory rates, such as oranges, apples and hard fruits. Ripe bananas are the for its flavor, texture, and high nutritional value

is popular with consumers. Because banana is a fruit in the climacteric fruit group has a high respiratory rate. The appearance of color skin is the main criteria of the customer for buying decision.

Focusing on a relation between the ripening process of banana and appropriate packaging. There are a number of relevant studies such as that by Wongs-Aree, et al.[2] to study various plastic bags for storage life extension of Emperor banana for export by keeping banana combs in sealed polyethylene bagged (PE), active polyethylene bags (AC) and ethylene absorbent bags (EA) and compare with non-bagged banana (control). All treatments were kept at 13°C for 30 days. Storage in PE bags significantly prevented weight loss and delayed the senescence of the banana by retarding peel yellow changes, firmness and an increase of total soluble solids compared to other treatments when control banana fully ripped on day 24. According to the previous studies about the ripening the process, banana undergoes significant color and textural transformations. The peel color changes from green to yellow due to the synthesis of a few pigments [3]. Consumers usually judge the quality of banana upon the first visual assessment. CSIRO [4] who conclude that color act as an important indicator of RS of banana to influences consumers acceptability. The peel color is used as a predictor of shelf-life for retail distribution. The objective of this research is to investigate the appropriate design selection of individual packaging with material type, packaging size, the percentage of permeability for gases and water vapor (% Opening air hole) by measuring Hom Thong banana ripening color scale from green to yellow color from the retail distribution to customers.

METHODOLOGY

The research adopts the methodology in Wongs-Aree, et al. [2] and modifies them to visual inspect by color [5]. The methodology of this research consists of three parts.

Part 1: Developing a packaging of individual Hom Thong banana

The researchers study various plastic bags in material type in sealed Linear Low Polyethylene bagged (LLDPE) and Polypropylene bagged (PP), Position of Opening air hole, Diameter of Opening air hole, Bagged size, the percentage of permeability for gases and water vapor (% Opening air hole) for storage life extension of Hom Thong banana for retail market by keeping one piece of banana in seal bagged and non bagged banana (control). All treatments were repeated five replicates and kept for two conditions; normal condition at 27 ± 3°C, Relative Humidity (RH) 60 ± 10% for 15 days. The condition of the experiment is illustrated in Table 1.

Table 1: Condition of Development a packaging of individual Hom Thong banana

Condition	Material Type	The position of the open-air hole	The diameter of the open-air hole (cm.)	Number of open-air holes	Bag size (cm)	Open-air hole (%)
1	LLDPE	[-/ - / -]	-	-	14x30	0
2	PP	[-/ - / -]	-	-	14x30	0
3	LLDPE	[-/ - / -]	-	-	20x30	0
4	LLDPE	[-/ - / -]	-	-	14x30	0
5	LLDPE	[- /Center/ -]	0.1	128	14x30	0.3%
6	LLDPE	[- /Center / -]	0.7	8	14x30	0.9%
7	PP	[- /Center / -]	0.7	8	14x30	0.9%
8	LLDPE	[Edge/ - Edge]	0.7	12	14x30	1.4%
9	LLDPE	[- / Center / -]	0.7	12	14x30	1.4%
10	LLDPE	[Edge/ Center /Edge]	0.7	12	14x30	1.4%
11	Non bagged banana					

Part 2: Aging condition

Simulation of Banana Storage Conditions in the retail market show as the Table 2. The experiment test in the aging condition at 29.3 ± 1 ° C, Relative Humidity 99% for eight days with wrapping with strength plastic film at the end of banana to help slow down respiration and test the direction of placing bananas in the distribution. This research compares two packed alignments;

horizontal and vertical packed orientation as the Figure 1. This is the comparison of how to effect for respiration rate of banana.

Table 2: Treatment condition

Condition	Material Type	The position of opening air hole	The diameter of the open-air hole (cm.)	Number of open-air holes	Bag size (cm)	Open-air hole (%)	Control respiration rate	Packed alignment
5	LLDPE	[- /Center/ -]	0.1	128	14x30	0.3%	Unwrapping	vertical
8	LLDPE	[Edge/ - Edge]	0.7	12	14x30	1.4%	Unwrapping	vertical
11	Non bagged banana (control)						Unwrapping	vertical
12	Non bagged banana with (control)						wrapping	vertical
13	LLDPE	[- /Center/ -]	0.1	128	14x30	0.3%	Wrapping	vertical
14	LLDPE	[Edge/ - Edge]	0.7	12	14x30	1.4%	Wrapping	vertical
15	LLDPE	[Edge/ - Edge]	0.7	12	14x30	1.4%	Wrapping	horizontal

Figure 1. Vertical and horizontal and packed alignment

Part 3: Banana ripening area Inspection

The methodology of this research is to select a banana color scale for consumption to adapt from the CSRIO standard by using a manual scale. The consumer's preference split into ten levels from 0 percent to 100 percent by calculating the percentage of the banana ripening area. The boundaries of the banana area divided into five slots and the level in each slot have three scales (0, 10, 20) as Figure 2. The Number of '0' scale means the full area of green color, the number of '10' scales mean the middle area between yellow and green color and the number of '20' scale means the full area of yellow color. The summary of the banana color scale is the percentage of the banana ripening. The jig divider for separating How Thong banana area is shown as the **Figure 2.** This research inspects the color by using the spectrometer color measurement CS-200 Konica Minolta, 1010 lux, Fluorescent three lamps, CIE standard from Color Research Center at RMUTT as the Figure 3.
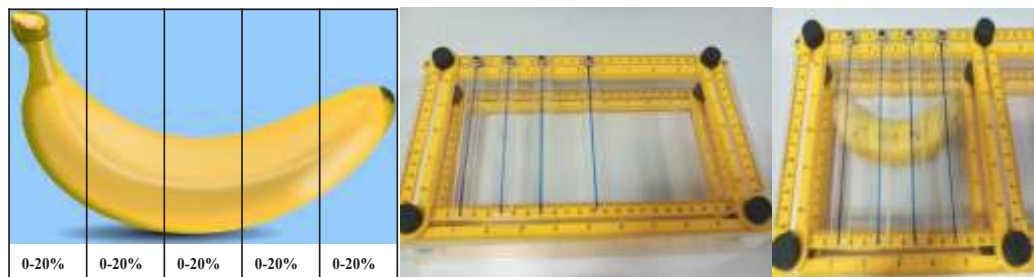

Figure 2. The boundaries of the banana area and jig divider

Figure 3. Color inspection with spectrometer color measurement

RESULT

According to the experiment of Hom Thong banana ripening color scale for individual packaging in the retail market. The result of Part 1 is shown that the several packaging with material type in sealed Linear Low Polyethylene bagged (LLDPE) and Polypropylene bagged (PP), Position of Opening air hole, Diameter of Opening air hole, Bagged size, the percentage of permeability for gases and water vapor (% Opening air hole) for storage life extension of Hom Thong banana for retail market by keeping one piece of banana in seal bagged and non bagged banana (control). All treatments were kept for two conditions; normal condition at $27 \pm 3°C$, Relative Humidity $60 \pm 10\%$ for 15 days. The result is shown in Figure 4.
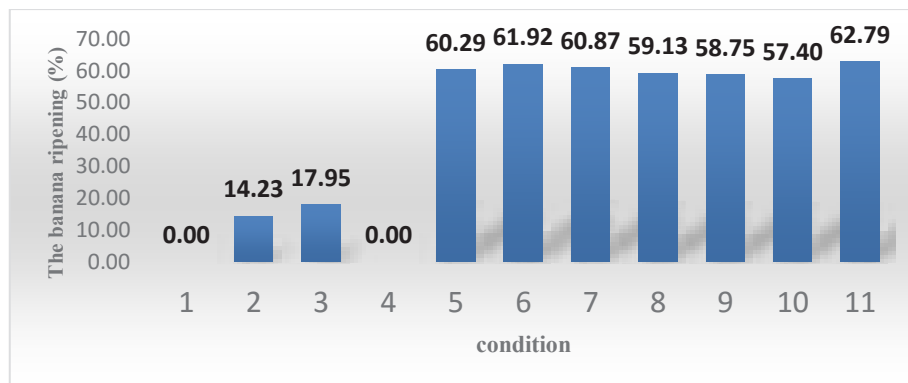

Figure 4. The percent of banana ripening in several packaging

From Figure 4 found that condition no. 10 is the lowest banaba ripening percent (57.40%). This condition is the best solution for packaging Hom Thong banana. The packaging specification is to select LLDPE material and make the open air hole in Edge/Center/Edge position. The diameter of the open-air hole is 0.7 cm. The total of the hole is 12 holes in the bagged size is 14x30 cm, the percentage of permeability for gases and water vapor is 1.4%. In the condition no.1, 2, 3 and 4 show the percentage of banana ripening is very low value but these conditions are not selected. Because three are not changed from green to yellow. The texture can not eat and when the bag is opened, there is a foul odor caused by fermentation in the state of oxygen-free breathing occurs.

The result of Part 2 Simulation of Banana Storage Conditions in the retail market at the aging condition at $29.3 \pm 1°C$, Relative Humidity 99% for 8 days with wrapping with strength film plastic at the end of the banana. This research compares two packed alignments; horizontal and vertical packed alignment. This is the comparison of how to effect for respiration rate of banana. The result is shown in Figure 5.
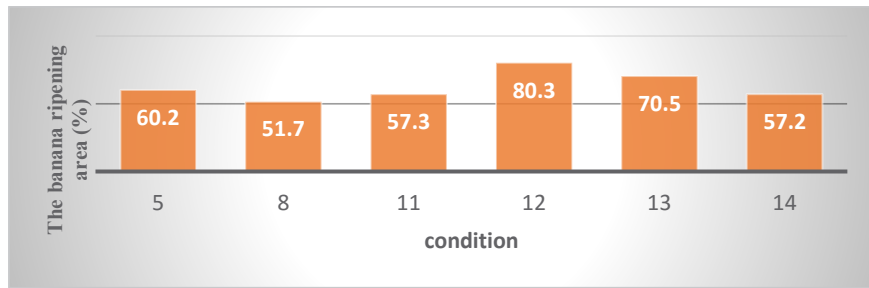
Figure 5. Simulation of Banana Storage Conditions at the aging condition

From Figure 5, the lowest percentages of banana ripening are condition no.8 (51.7% banana ripening area). The condition no.12, 13, and 14 with wrapping with strength film plastic at the end of banana cannot slow down respiration in aging condition.
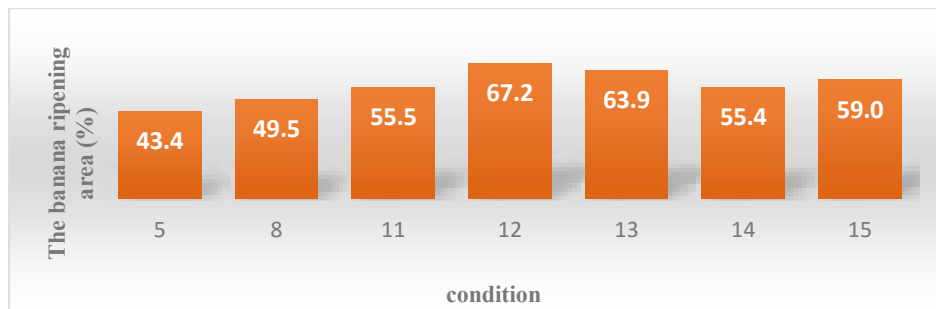

Figure 6. The comparison of packed alignments

From Figure 6, this experiment compares two packed alignments; horizontal and vertical packed alignment. From the result found that the vertical banana (a condition no. 14) is lower ripening banana 55.4% than the horizontal banana (condition no.15) with 59%. The result in Part 3 is shown that the color inspection spectrometer color measurement. The result of this research found that the color of Hom Thong bananas for the retail market can be divided into ten color scales in green color is the average value of u'0.1836 and the average value of v'0.5403 as the Table 3. The middle color green between yellow is the average value of u'0.2088 and the average value of v'0.5444 as the Table 4. The yellow color is the average value of u'0.0.213 and average value of v'0.538 as the Table 5.

Table 3: Average u' and v' value of the green banana color

No.	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Avg u'	Avg v'	Figure
										Green Banana at five points											
1	G*1.1	0.1881	0.5376	G*1.10	0.1888	0.5403	G*2.1	0.1876	0.538	G*2.10	0.1854	0.54	G*3.1	0.1789	0.5421	G*3.10	0.1891	0.5396	0.1863	0.5396	
2	G*1.2	0.1865	0.5354	G*1.9	0.1851	0.5414	G*2.2	0.1852	0.5364	G*2.9	0.1819	0.5418	G*3.2	0.1798	0.5365	G*3.9	0.188	0.5406	0.1844	0.5387	
3	G*1.3	0.1816	0.541	G*1.8	0.185	0.541	G*2.3	0.1831	0.541	G*2.8	0.185	0.5414	G*3.3	0.1768	0.5428	G*3.8	0.1828	0.5421	0.1816	0.5416	
4	G*1.4	0.1834	0.5386	G*1.7	0.1834	0.5421	G*2.4	0.1821	0.5412	G*2.7	0.1788	0.5419	G*3.4	0.1825	0.5379	G*3.7	0.1827	0.5434	0.1822	0.5409	
5	G*1.5	0.1829	0.5398	G*1.6	0.1825	0.5432	G*2.5	0.1818	0.541	G*2.6	0.18	0.542	G*3.5	0.1921	0.5359	G*3.6	0.182	0.5436	0.1836	0.5409	
														Average				0.1836	0.5403	

Table 4: Average u' and v' value of middle green between yellow banana color

No.	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Avg u'	Avg v'	Figure
										Green and Yellow Bananas at five points											
1	S*1.1	0.1871	0.5442	S*1.10	0.1883	0.5433	S*2.1	0.1991	0.5436	S*2.10	0.1998	0.5418	S*3.1	0.1869	0.5445	S*3.10	0.1888	0.5432	**0.1917**	**0.5434**	
2	S*1.2	0.2005	0.5455	S*1.9	0.2087	0.5439	S*2.2	0.2149	0.5454	S*2.9	0.2034	0.5441	S*3.2	0.2012	0.5469	S*3.9	0.2096	0.5435	**0.2064**	**0.5449**	
3	S*1.3	0.2141	0.5452	S*1.8	0.2115	0.5452	S*2.3	0.2165	0.5467	S*2.8	0.2142	0.5451	S*3.3	0.2145	0.5462	S*3.8	0.2149	0.5449	**0.2143**	**0.5456**	
4	S*1.4	0.2161	0.5447	S*1.7	0.2131	0.5448	S*2.4	0.2167	0.5461	S*2.7	0.2153	0.5428	S*3.4	0.2163	0.5446	S*3.7	0.216	0.5451	**0.2156**	**0.5447**	
5	S*1.5	0.2187	0.5436	S*1.6	0.2144	0.5438	S*2.5	0.2158	0.5453	S*2.6	0.2145	0.5412	S*3.5	0.2186	0.5433	S*3.6	0.2152	0.5441	**0.2162**	**0.5436**	
														Average				0.2088	0.5444	

ORAL SESSION

Table 5: Average u' and v' value of the yellow banana color

No.	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Code	u'	v'	Avg u'	Avg v'	Figure
							Yellow Bananas at five points														
1	Y*1.1	0.2142	0.5397	Y*1.10	0.2147	0.5412	Y*2.1	0.2125	0.5375	Y*2.10	0.2159	0.5348	Y*3.1	0.2114	0.5372	Y*3.10	0.2127	0.5337	**0.214**	**0.537**	
2	Y*1.2	0.2144	0.5396	Y*1.9	0.213	0.5394	Y*2.2	0.2135	0.54	Y*2.9	0.2159	0.5385	Y*3.2	0.2095	0.5354	Y*3.9	0.2101	0.5333	**0.213**	**0.538**	
3	Y*1.3	0.2134	0.5403	Y*1.8	0.2122	0.537	Y*2.3	0.2137	0.54	Y*2.8	0.2112	0.5347	Y*3.3	0.2107	0.5363	Y*3.8	0.2092	0.5323	**0.212**	**0.537**	
4	Y*1.4	0.2139	0.5417	Y*1.7	0.2127	0.5388	Y*2.4	0.2153	0.5426	Y*2.7	0.2115	0.5367	Y*3.4	0.2108	0.5358	Y*3.7	0.211	0.5365	**0.213**	**0.539**	
5	Y*1.5	0.2148	0.542	Y*1.6	0.2117	0.5365	Y*2.5	0.2131	0.5407	Y*2.6	0.2092	0.533	Y*3.5	0.2107	0.5342	Y*3.6	0.2123	0.5371	**0.212**	**0.537**	
															Average				0.213	0.538	

DISCUSSION

The objective of this research is to investigate the appropriate design selection of individual packaging by measuring Hom Thong banana ripening color scale from green to yellow color from the retail distribution to customers. As the result is shown is banana ripening color scales set for classification which is the appropriate design selection of individual packaging to keep Hom Thong banana for the long life of storage. The comparison between the material type of packaging, it found that Polyethylene and Polypropylene material does not differ of the percentage of banana ripening color scale. The packaging size the effect, the result found that small area (14x30 cm) can keep a long life of storage than the big area (20x30 cm). The comparison between closed seal packaging and opening air hole packaging has different significantly in banana ripening color scale. The suitable permeability for gases and water vapor at 0.3-1% can reach to desired banana respiration rate and keep long life of storage than closed seal packaging. The contribution of this research can expand to agricultural farmers to apply the appropriate packaging for Hom Thong banana in the retail market. The banana ripening color scale can use to classify banana which is suitable for the retail market and inform the customers to make a buying decision. The limitation in banana color scale applications is only in gross Micheal banana in the area of central region Thailand. For further research will extend the scope from farm to folk by applying the color scale methodology to determine the banana harvest at the farm.

ACKNOWLEDGEMENTS

REFERENCES

[1] Pisanwanich, A. (2017). *Thai banana in Asian*. Department of International Trade Promotion, Ministry of Commerce. Thailand: Bangkok Post.

[2] Wongs–Aree, C., Jirapong, C., Worarad, K., and Boonyaritthongchai, P. (2013). *Comparative study on different storage life extension banana ('Kluai Khai') in deferent plastic bags for export*. Agricultural Science Journal, 44(2), 545-548.

[3] Yang, X., Song, J., Fillmore, S., Pang, X., and Zhang, Z. (2011). Effect of high temperature on color, chlorophyll fluorescence and volatile biosynthesis in green-ripe banana fruit. *Postharvest Biology and Technology*, 62(3), 246–257.

[4] CSIRO. (1972). *Banana ripening guide.* Commonwealth Scientific Industrial Research Organization Division of food research circular 8: Australia: North Ryde, N.S.W.

[5] Juncai, H., Yaohua, H., Lixia, H., Kangquan, G., and Satake, T. (2015). Classification of ripening stages of bananas based on support vector machine. *International Journal of Agriculture & Biology*, 8 (6), 88-103.