Food Research 6 (Suppl. 1) : 86 - 88 (2022)
Journal homepage: https://www.myfoodresearch.com

FOOD RESEARCH

FULL PAPER

Improving the appearance of Kuini (*Mangifera odorata*) using carbon bagging during the preharvest stage

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Article history:
Received: 4 November 2021
Received in revised form: 30 December 2021
Accepted: 2 January 2021
Available Online: 29 June 2022

Keywords:
Skin Colour,
Chlorophyll,
Anthocyanin,
Fruit Quality,
Appearance

DOI:
https://doi.org/10.26656/fr.2017.6(S1).014

Abstract

Kuini (*Mangifera odorata*) is one of the important indigenous fruits that can be found in Malaysia. This fruit belongs to the same genus as the mango and is known for its strong and pungent smells. Usually, this rare fruit is eaten fresh, semi-cooked in local delicacy, or is used to produce other products such as juice or functional drink. Naturally, Kuini has green colour skin even after the fruit has fully ripened. This study was conducted to evaluate the effects of carbon bagging during the preharvest stage on fruit quality and skin colour changes. Fruits were tagged after the setting stage and bagged with a carbon bag after reaching approximately 16 cm in circumference. Regular white bags were used as control. Results have shown a significant difference in skin colour (L, a*, b*, chroma and hue) where fruits bagged using carbon paper bag exuded a yellowish hue as compared to the control. However, for the chemical content of the fruits, there are no significant differences between fruits bagged using carbon paper bag and white colour bag in terms of total soluble solid (TSS), pH and titratable acidity. In short, the use of carbon bags during the preharvest stage can change fruit skin colour without compromising the fruit quality.

1. Introduction

Kuini or Kwini is a local name for *Mangifera odorata* that is considered an underutilized fruit in Malaysia. This fruit was described to exhibit slightly fibrous flesh with an intense and earthy aroma (Campbell, 2007). Kuini is often consumed as fresh fruits or semi-cooked in traditional cuisine such as 'sambal' or sweet dessert. A previous study had conducted to determine the optimum harvesting time where fruits are suitable to be harvested at 11-12 weeks after fruits is set to ensure it has optimum eating quality with a sweet taste and less fibrous flesh (Wan Mahfuzah *et al*., 2018). One of the setbacks in kuini and other *Mangifera spp* production is pest and disease attacks on fruits that can affect fruits' physical appearances such as sooty mould and fruit borer. However, proper control measures during preharvest stages such as the use of paper bags can help to improve the quality including cosmetic values of fruit. The use of bagging for Mangifera fruit such as mango, especially on high-quality cultivars such as Harumanis is already considered a common practice in Malaysia. A study in 1997 had proved that the use of bagging during the preharvest stage on Keiit mango can reduce anthracnose and stem-end rot (SER), caused by *Colletotrichum* and *Dothoriella spp*., respectively (Hofman *et al.*, 1997). Hence, the use of bagging was practised in Kuini upscaling plot in MARDI Sintok.

Naturally, Kuini fruits were green in colour at maturity until the senescence stage and this can be unattractive to some consumers. The previous study on other crops such as apple (Shen *et al*., 2012), and mango (Hofman *et al*., 1997; Ding and Syakirah, 2010) had shown that the use of bagging has effects on fruit quality and phenolic compounds. As for Kuini, no previous study on bagging was found due to the nature of this fruit as one of the underutilised fruits in Malaysia with very small production per year where 40% of growers only have backyard orchards with 1-3 trees inherited from generations to generations. Only 4.5% of farmers plant kuini to sell to the market (Noorlidawati *et al*., 2017). Thus, this study was conducted to evaluate the use of carbon lining paper bags during the bagging stage towards fruits quality especially on skin colour to enhance the appearance of fruits to be more attractive to new markets or consumers.

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eISSN: 2550-2166
Published by Rynnye Lyan Resources

2. Materials and methods

2.1 In field preparation

Mangifera odorata elite accession plots in Sintok, Kedah were used in this study and only trees from the same accession were selected which is 'Kijal'. Fruits were tagged after the fruit set stage which is one week after flowering. Fruits were bagged using two types of bags, a plain white waterproof paper bag as control and a carbon lining paper bag with a layer of brown paper on the outside as control. Fruits were then harvested at Week 12 and brought to the postharvest laboratory for postharvest handling activities such as trimming, sorting and cleaning with clean water before conducting a fruit quality assessment.

2.2 Fruit quality assessments

Quality assessments were done on the day of harvesting to evaluate skin and flesh colour, total soluble solids (TSS), pH, titratable acidity (TA), and sugar-acid ratio. Total soluble solid (TSS) was measured using a digital handheld refractometer, ATAGO CO. LTD PAL-α, while pH was taken by using the pH meter model HANNA Instrument HI2211. Titratable acidity content was measured by titrating 20 mL extract from a sample with 0.1 M 1-1NaOH until it reached pH 8.2, while for ascorbic acid, 10 mL extract from 10 g and 100 mL 3% metaphosphoric acid were titrated with standard dye until the extract turned into faint pink colour (Nur Azlin *et al.,* 2015). Fruits were also observed to note any visible changes such as disease incidence and external quality. Skin and flesh colour were measured using a Konica Minolta handheld chroma meter (CR400) to obtain values of lightness (L), a* and b* while chroma and hue values were calculated from L, a* and b* values.

3. Results and discussion

Results (Table 1) have shown a significant difference in skin colour (L, a*, b*, chroma and hue) where fruits bagged using carbon paper bag exuded a yellowish hue as compared to the control that maintains its green skin colour. This is in agreement with the previous study performed on various types of fruits such as Harumanis mango (Ding and Syakirah, 2010), and Keitt mango (Hofman *et al*., 1997) where the use of bagging during the preharvest stage has given the most impact on skin colours. The use of carbon lining bagging will reflect the light received by the fruits. Energy from light is essential in the photosynthesis process by chlorophyll on skin colours. Disruption of this process lowers the chlorophyll contents on skins thus enabling readily available carotenoid pigments to unmask the green colour from chlorophyll pigments. Hence, the yellow skin colour was formed from this carotenoid. This is supported by a study by Ding and Syakirah (2010) where different bagging treatments had no significant differences in carotenoid contents and only affected chlorophyll contents.

As for the flesh colour, only L values significantly differ between these two treatments where control samples have a lighter colour than carbon lining bagged fruits. An experiment conducted by Hwang *et al*. (2004) on grapefruit discovered that bagging has slight effects on the fruit's flesh colour too but not as significant as skin colour.

In terms of chemical contents of the fruits (Table 2), there are no significant differences observed between fruits bagged using carbon paper bag and white colour bag in terms of total soluble solids (TSS), pH and titratable acidity but there is a slight difference in the sugar-acid ratio where control fruits score higher than fruits bagged using carbon lining paper. However, the evaluation was done on the day of harvesting and the ripening process will continue to improve the chemical quality of fruits as they ripen. Overall, it can be said that using a carbon lining paper bag can help to improve the skin colour without compromising the eating quality of fruit.

Table 2. Changes in total soluble solids (TSS), pH, total titratable acidity (TTA), sugar acid ratio of Kuini (*Mangifera odorata*) bagged using carbon lining bag and control (white bag) during preharvest stage

Treatment	Total soluble solid (°Bx)	pH	Total Titratable Acidity (g/L)	Sugar Acid Ratio
Carbon lining	4.412	3.25	2.299	0.247
Control	5.738	3.35	2.322	0.320
T-Test	ns	ns	ns	*

ns, non-significant, *significant at p≤0.05.

Table 1. Changes in colour (L, a*, b*, chroma and hue) of fruit skin and flesh of Kuini (*Mangifera odorata*) bagged using carbon lining bag and control (white bag) during preharvest stage

	Skin					Flesh				
Treatment	L	a*	b*	Hue	Chroma	L	a*	b*	Hue	Chroma
Carbon lining	70.105	-6.291	49.586	82.701	50.044	69.746	-6.163	48.274	82.695	48.703
Control	48.081	-14.903	34.239	66.461	37.349	76.03	-4.288	51.324	85.114	51.528
T-Test	**	**	*	*	*	**	ns	ns	ns	ns

ns, non-significant, *significant at p≤0.05, **highly significant at p≤0.05.

eISSN: 2550-2166

4. Conclusion

In short, the skin colour of Kuini can be a major improvement for this underutilized fruit in giving a new impression to the consumer by utilising simple processes such as bagging. It will create a new niche market for premium and rare products by combining proper postharvest handling such as harvesting at the optimum time, bagging and using a natural coating to prolong the shelf life. The use of carbon bags during the preharvest stage can change fruit skin colour without compromising the fruit quality.

Conflict of interest

The authors declare no competing interests.

Acknowledgement

The authors would like to acknowledge the Ministry of Agriculture and Agro-based Industry Malaysia for the research funding through the MARDI Development Fund: 21003004070001-2018-B

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