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Effect Of Storage Duration On The Color Value Of Sweet Potatoes (*Ipomoea batatas*)

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Abstract

Sweet potato (Ipomoea batatas) is a cultivar belongs to the family of Convolvulaceae, a herbacous and woody species. This cultivar is recommended as a superior source for the production of foods with health benefits.The quality of sweet potatoes must be maintained especially during postharvest storage to ensure its health benefits not affected. Colour is an important parameter which reflects the quality of sweet potato in terms of appearance and nutrients.Therefore, the effect of storage duration on the colour of sweet potato after exposure for ten days at room temperature were investigated. The colour parameters in terms of L-,a-,b-values, Hue and Chroma were determined using colour reader (CR-10,Conica Minolta, Japan). A significant ($p < 0.05$) decreased about 8% and 28.64% was observed in L-values and a-values respectivley after 10 days of storage. The b-values and hue increased significantly ($p < 0.05$) by 26.49% and 43.28% respectively. However, the chroma value shows no significant different during the storage. Therefore, this finding indicates that storage time significantly effects the color value of sweet potatoes. This knowledge will offer potential application in sweet potatoes industry especially in developing a system to maintain the freshness and quality of sweet potatoes during the storage.

Keywords: Sweet potatoes, storage, CIE Lab value, colour change

Introduction

The sweet potatoes (*Ipomoea batatas*) or locally known as "Ubi Keledek" is one of the most important staple food in the world that approximately 80-90% of the dry matter (DM) is composed of carbohydrates (Vincent, 2009). It can be in fusiform globular, round or ovate in shape, with a smooth, ridged or rough surface. Its skin colour varies from white to yellow, orange, red, purple or brown and flesh may be white, yellow, orange, reddish or purple (Vincent,2009). The weight usually about 150 to 250 g (Rosnani et.al, 2017).

In 2017, Malaysian Agriculture Research and Development Institute (MARDI) had reported that 2,799.85 ha of sweet potatoes's plantation area leads to the production of 43,211.8 metric tons per year. It is also been stated that the production value for this crop is equivalent to 70.867 million Ringgit Malaysia/17.1 million US$ with the average production yield of 16.7 tons/ha. In order to increase the production of sweet potatoes in Malaysia, MARDI had also developed three varieties of purple flesh sweet potatoes known as Anggun 1, Anggun 2 and Anggun 3. These varieties classified based on shape of leaves and roots. The advantages of these varieties are high in anthocyanin content (185 – 316 mg/L), ability to survive in low fertility soil and resist to disease (Rosnani et.al, 2017).

The first quality of food usually determines based on its visual appearance. Appearance analysis of foods (colour, taste, odour and texture) are used in maintenance the food quality throughout and at the end of processing (Medeni, 2001). Colour is one of the most important appearance contribute to the customer acceptability. CIE L*a*b* color space is a system defined by the Commision Internationale de I'Eclairage (CIE), used to evaluate the lightness (L), red/green (a) coordinates and yellow/blue (b) coordinates. The study shown that L values of peel colour of sweet potatoes ranged from 28.7 to 63.1, while a and b values ranging from 6 to 16.9 and 4 to 19.3 respectively (Adebisola et al., 2009). Picha(1985) reported that lighter colour chip of sweet potatoes have higher total carotenoid content. However, storage also has a substantial influence on the final quality of fruit, as it affects the appearance and induces colour change (Dobrzañski et al., 2001; Kader, 1999; Kameoka et al., 1994). Storage conditions such as duration, temperature and humidity influenced in keeping the food products in a good quality (Dobrzañski et. Al, 2002). Vincent stated that tubers can be stored at 30^{0}C and 90-98% relative humidity for 4-7 days with good ventilation. The storage duration for sweet potatoes can be up to to 3 months in ventilated village storage structures in which the relative humidity may be controlled at ambient temperature (Data et al., 1987). Temperature of storage can influence colour and texture, mainly through its effect on respiration (Alvarez et al., 2000; Laza et al.,2001 and Nourian et al.,2003a). Temperature below 5⁰C inhibit respiration but continued hydrolysis of starch leads to the accumulation of reducing sugars, to the detriment of colour, flavour and texture (Blenkinsop et al.,2002;Chourasia et al.,2001;David et al.,2004). However, according to Uritani, Data and Tanaka (1984), the storage temperature lower than 8⁰C may cause chilling injuries. While temperature above 21⁰C increase respiration and prevent accumulation of reducing sugars but cause spoilage (Cheftel et al.,1992). Jenkin stated that when tubers are stored at 24-35⁰C, only 20-25% losses occured.

To the best of our knowledge, there is a limited number of research on the effect of storage duration on colour of sweet potatoes at room temperature. Therefore, as storage condition (duration and temperature) may affect the colour of sweet potato, the present study aims to appraise the effect of storage duration on color value of sweet potatoes at room temperature.

Materials and methods

Preparation of sample

Sweet potato was obtained from a farm at Semenyih, Selangor. Variability of the raw material were minimized by selecting the sweet potatoes from the same variety known as Anggun 1 and it was harvested once reached commercial maturity stage which normally 3 months after planting. Sample was completely washed with tap water immediately to remove soil adhesion and other extraneous material; then air-dried. Three fresh roots selected in weight of 150-250 g/root size and stored at room temperature for 10 days.

Colour measurement

The surface colour of fresh tubers were evaluated visually by using colour reader (CR-10,Conica Minolta, Japan) at room temperature. The color values were measured at three different locations on the surface of tubers as shown in Figure 1. The colour values were expressed as L* a* b*. The average values of three replications were reported. The tubers must be placed completely in contact with the light port of colour reader to avoid any light leakage hence affect the reading of the data. Chroma (C) and hue angle colour parameters were calculated as below (Pankaj et al., 2012):

$$C = \sqrt{a^2 + b^2} \quad (1)$$

$$H = Tan^{-1}\left(b/a\right) \quad (2)$$

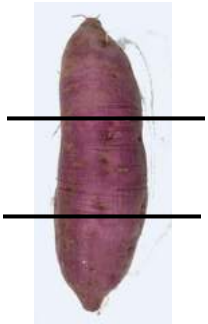

Figure 1: Longitudinal section of fresh Anggun 1 sweet potatoes

Statistical analysis

The data collected were analyzed using SPSS Statistics 21.0 edition whereby Duncan's test was tested to evaluate the significant difference between mean values.

Results and discussion

Colour is an important quality attributes in the food and bioprocess industries as it influences consumer's choice and preferences (Pankaj et al., 2012). CIELAB colour scales were opponent-type systems commonly used in the food industry in order to monitor and control product quality (Pereira et al., 2009; Yu et al., 2003). Colour parameters L, a, b, chroma and hue are the common quatitative values attribute to the colour analysis. These parameters were affected by the storage duration of the samples.

Colour parameters L, a, b

Table 1 shows the effects of different storage duration on the colour of Anggun 1 at room temperature. From Table 1, it shows that the original colour parameters L, a, b which is during 0 day were 44.40 ± 1.66, 12.90 ± 3.43 and 11.07 ± 3.43 respectively. These results are in line with the values reported by Adebisola et al. (2009).

L is used in colour coordinates to denote the psychometric index of lightness (Pankaj et al.,2012). The lightness of Anggun 1 during 10 days of storage ranged from 45.37 ± 0.83 to 41.73 ± 0.77 at room temperature. The L-values of the samples were decreased gradually as a function of storage time. The L-value of the samples after 10 days (41.73 ± 0.77) showed significantly (p < 0.05) lower than 0 day (45.37 ± 0.83). A decline trend also reported by Marti (2004), where the L-values of sweet potatoes decrease from 50.1 to 49.3 during the storage. Since the L-value is a measure of the colour in the light-dark axis, the decreasing value indicates that the samples were turning darker and conversely. This change might be due to the respiratory activity and browning reaction (Hernandez et al., 2014) which increase during the storage.

The parameter a-values used to indicate the reddish colour (positive values) and greenish colour (negative values). The reddish colour normally related to the water soluble anthocyanin while green colour showed the fat soluble chlorophyll (Jackson, 2016). In Table 1, the result shows the redness (a-value) with the decreasing trend during the storage from the 14.00 ± 1.32 to 9.99 ± 1.08. The a-values showed a significant decreased ($p < 0.05$). These decreasing values in redness of the samples can be linked with the degradation of red anthocyanin pigments (Carolien et al., 2017).

The b-value is a measurement for yellowish colour (positive values) and bluish colour (negative value). The yellowish colour related to carotenoids and flavonoids pigments while bluish colour linked to anthocyanin content. Table 1 shows that b-values ranged from 11.21 ± 0.66 to 14.18 ± 0.61 during 10 days of storage. The b-values increased by 26.49 % after 10 days of storage. Significant different ($p < 0.05$) was observed between 10 days and 0 day of storage. Due to this increment, it might be dependent on the concentration of the beta carotene pigment in the samples (Woolfe, 1992). Therefore, the increasing trend may due to the decomposition of carotenoid pigments in sweet potatoes (Kostaropoulus & Saravacos, 1995; Lee & Coates, 1999; Weemaes et. al., 1999).

Table 1: Colour value of Anggun 1 as affected by different storage duration.

Time (day)	L	a	b	Chroma	Hue
0	45.37 ± 0.83 ^{a}	14.00 ± 1.32 ^{a}	11.21 ± 0.66 ^{a}	17.94 ± 1.39 ^{a}	0.67 ± 0.03 ^{a}
2	44.15 ± 0.80 ^{a}	12.94 ± 1.12 ^{ab}	12.55 ± 0.79 ^{b}	18.05 ± 1.02 ^{a}	0.77 ± 0.05 ^{b}
4	42.84 ± 0.25 ^{b}	12.13 ± 1.39 ^{abc}	12.91 ± 0.37 ^{b}	17.73 ± 1.13 ^{a}	0.82 ± 0.05 ^{bc}
8	41.79 ± 0.76 ^{b}	11.09 ± 1.43 ^{bc}	13.02 ± 0.51 ^{b}	17.11 ± 1.22 ^{a}	0.87 ± 0.05 ^{c}
10	41.73 ± 0.77 ^{b}	9.99 ± 1.08 ^{c}	14.18 ± 0.61 ^{c}	17.63 ± 1.06 ^{a}	0.96 ± 0.03 ^{d}

Result were expressed as mean ± standard deviations (n = 3).

Values sharing different letters (a,b,c,d) within the column are expressed as significantly different ($p < 0.05$) during the storage time.

L* values indicates lightness of the samples; 100 = white, 0 = black

a* values designate redness when positive; greeness when negative.

b*values represent yellowness when postive, blueness when negative

Chroma and hue

Chroma and hue values were calculated using Eqs. (1)-(2) respectively and shown in Table 1. The chroma value attribute to the degree of difference of a hue in comparison to a grey colour with the same lightness. The higher the chroma values, the higher is the colour intensity of samples recognized by humans (Pankaj et al., 2012). The chroma values ranged from 17.94 ± 1.39 to 17.63 ± 1.06 during 10 days of storage at room temperature. Slightly changes about 0.61% was found in chroma values during 2 days of storage that indicates stability of yellow colour in Anggun 1 (Barreiro et al., 1997; Lee at al., 1999; Palou et al., 1999). However, the influence of storage time was not significant ($p > 0.05$) on the chroma values. The finding of chroma value in the current study was in contrast with a study done by Marti (2004), which reported chroma values decreased over storage time from 27.7 to 25.8. This might be due to the different types of cultivar, geographical location and storage condition.

Another colour parameter, hue angle is attributed to which colours have been traditionally defined as reddish, greenish and others. It used to determine the difference of a colour with reference to grey colour with the same lightness (Pankaj et al., 2012). Table 1 showed the hue ranged from 0.67 ± 0.03 to 0.96 ± 0.03 after 10 days of storage. Significant increased ($p< 0.05$) was observed in hue values during 10 days of storage. This increment was in linked with the b-values. These values suggested the stability colour in orange-red angle as stated by Maskan (2001), green colour (when Hue > 90^{0}C) and orange-red (when Hue < 90^{0}C). This result was parallel to that conveyed by Marti (2004), which revealed that the hue increased linearly over time of storage.

Conclusion

In this research, the effect of storage duration on changes in colour values of Anggun 1 at room temperature was systematically investigated. All colour parameters were influenced significantly from the storage duration except for chroma. The result suggested that after 10 days of storage, respiratory and browning reaction increased as the value of L decreased. The decreasing trend redness (a-values) also can be linked to the degradation of anthocyanin content. The yellowness (b values) of Anggun 1 increased during the storage as related to the decomposition of carotenoid pigments. Hue values were in line with b-values as both result showed that the stability of yellowness in Anggun 1.

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