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COLOR-BASED ANALYSIS FOR NON-DESTRUCTIVE QUALITY EVALUATION OF SIAMESE ORANGE *(Citrus nobilis)* DURING STORAGE IN ROOM AND COLD TEMPERATURE

COLOR-BASED ANALYSIS FOR NON-DESTRUCTIVE QUALITY EVALUATION OF SIAMESE ORANGE (*Citrus nobilis*) DURING STORAGE IN ROOM AND COLD TEMPERATURE

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Abstract. This research aimed to develop image processing program to extract several features of Siamese orange images and to determine the appropriate key features of the orange images which were highly correlated with physical and chemical characteristics of Siamese orange. A sample size of 210 oranges was stored in a room temperature (25-27 ºC) and cold temperature (8-10 ºC) for 30 days. All oranges were captured their images using a webcam and were subsequently measured their physical and chemical characteristics, i.e. weight, hardness, and total soluble solids (TSS). The visual parameters of images measured were binary area in pixels, RGB color, HSV color, CIE-Lab color and gray value. The results showed that there was a high correlation between fruit weight and binary area in both room and cold temperature storage with $r^2 = 0.8197$ and $r^2 = 0.8291$, respectively. On the other hand, color values cannot be used to estimate fruit hardness since the correlation coefficient was too small. The highest correlation coefficient between them was $r = 0.114$ which was achieved from the correlation between fruit hardness and hue value. The r value of TSS and some color components was nevertheless relatively strong. Based on the experiments, hue value of HSV color model and a* component of CIE-Lab color model have fairly strong correlations with TSS of oranges stored in room temperature which were indicated from the r^2 value of 0.7473 and 0.7029, respectively.

Keywords: image processing, physical characteristics, chemical characteristics, total soluble solids, RGB

1. Introduction

Citrus is one of the most common commercialized horticulture products which may easily deteriorate its quality during storage. The quality deterioration can be investigated through the changes of its physical as well as mechanical, chemical and optical properties. The information of quality properties of citrus are important to be understood since they have a significant role in machinery design as well as in harvesting process and other postharvest activities, such as sorting, grading, storage, packaging, transportation, and fruit processing (e.g. drying, cooling, heating, etc.).

A lot of studies have been established to identify quality properties of citrus. Rafiee et al. (2007) did a research to figure out physical properties of Iranian fruit, i.e. Bergamot (*Citrus medica*). Sharifi et al. (2007) performed a study to identify physical properties of Tompson citrus. Abdullah et el. (2012) studied the physical properties of musk lime (*Citrus microcarpa*). Moreover, Pawar et al. (2015) identified physical and mechanical properties of Kagzi-lime. Joshi and Awate (2016) studied physical and mechanical characteristics of citrus for sorting and grading. Olabinjo et al. (2017) conducted a research to identify physical and chemical of sweet orange (*Citrus sinensis*) peel.

Quality evaluation of citrus is commonly conducted destructively. For instance, fruit hardness is usually measured by penetrating a plunger tip into citrus peel using a fruit penetrometer. In addition, total soluble solid (TSS) which is one of the most important chemical properties of fruits is commonly measured by placing a couple of drops of citrus juice onto the prism of a refractometer. To extract citrus juice, indeed, some samples of citrus must be squeezed and such practice is obviously destructive.

Recent developments of computation technology has led to enhancement of agricultural practices, both on-farm and off-farm activities. One of the renowned methods that has been widely used to examine horticultural products non-destructively is image processing. Therefore, this research aimed to analyze the changes of citrus quality during storage in room and cold temperature as well as to develop image processing program to extract several features of Siamese orange images and to determine the appropriate key features of the orange images which were highly correlated with physical and chemical characteristics of Siamese orange during storage in room and cold temperature.

2. Materials and methods

2.1. Raw materials preparation

Harvested siamese oranges were obtained from a local citrus farm in Kalikajar Village, Purbalingga Regency, Indonesia. All samples of the oranges were picked from trees at relatively homogeneous period, i.e. around 200 days after blossoms. A sample size of 210 oranges was prepared prior to data acquisition in the Laboratory of Food and Agricultural Product Processing, Department of Agricultural Technology, Jenderal Soedirman University. These fruits were firstly rubbed using a clean damp cloth to remove dirt and foreign materials from the epicarp.

After cleaning the oranges peels, the fruits were then split into two storage treatment, i.e. in room temperature (25-27 ^{o}C) and in cold temperature (8-10 ^{o}C). All samples were stored under the two conditions for 30 days. Several tools and devices were utilized to measure fruit quality parameters, i.e. electronic balance, fruit penetrometer, hand refractometer, lightmeter, and a closed box with a webcam and controlled lighting system for image acquisition.

2.2. Data acquisition

There were four types of fruit's properties measured in this research, i.e. physical properties (weight), mechanical properties (hardness), chemical properties (total soluble solid) and optical properties (color). During storage, every five days, five oranges were randomly chosen for measurement of their properties.

To determine fruit weights, five orange samples were randomly selected from each treatment and were carefully weighed using an electronic balance to an accuracy of 0.01 g. The weighing procedure is replicated three times, and the average value was taken and recorded. Fruit hardness was measured using fruit penetrometer by manually penetrating a plunger tip into orange peel. This procedure was also replicated three times and the average value was calculated. To measure total soluble solid, citrus juice must firstly be extracted by squeezing some orange samples. A couple of drops of citrus juice was then placed onto the prism of a refractometer. Refractometer is an instrument to quantify substances dissolved in water and certain oils using the principle of light refraction through liquids.

To determine color values of Siamese orange, an image processing approach was applied. Firstly, oranges were put in the middle of the closed box base and exactly under the webcam attached. The light intensity in the closed box was maintained relatively uniform with a range of 280-300 lux. The images of oranges were then captured by means of a webcam and subsequently stored as JPG files in a computer.

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The recorded images were then processed to extract their visual features using a developed image processing technique. Some measurement activities can be seen in Figure 1.

(a) (b) (c) (d)

Figure 1. Measurements of orange quality parameters: (a) weight, (b) hardness, (c) total soluble solid, and (d) color measurement using image processing technique.

2.3. Image processing technique

Orange images captured using a webcam were then processed through several steps of image processing technique. All image processing program in this research was developed using Matlab R2009b software. After image acquisition, the next step was image segmentation. In this step, an orange image was distinguished from its background through a thresholding method. In order to ease and speed up advanced processing without significantly losing important information of image data, we selected a smaller region of each segmented image which was located in the middle of image area. This region selection was conducted by determine center of gravity (COG) of each orange image then cropped a rectangular area of 101×101 pixels with the COG as the center of the rectangular. An example of the image segmentation process is shown in Figure 2.

Once orange images were segmented, a number of image features were subsequently extracted. In this research, the main features extracted included binary area, mean RGB, mean HSV and mean L*a*b*. RGB color values were converted to HSV and L*a*b* color by using the following formulae:

- RGB to HSV color conversion:

$$H = \tan\left(\frac{3(G-B)}{(R-G)+(R-B)}\right)$$

$$S = 1 - \frac{\min(R,G,B)}{V}$$

$$V = \frac{R + G + B\,B}{3}$$

- RGB to L*a*b* color conversion:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0{,}4125 & 0{,}3576 & 0{,}1804 \\ 0{,}2127 & 0{,}7152 & 0{,}0722 \\ 0{,}0913 & 0{,}1192 & 0{,}9502 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$L^* = 116 f\left(\frac{Y}{Y}\right) - 16$$

$$a^* = 500\left[f\left(\frac{X}{X}\right) - f\left(\frac{Y}{Y}\right)\right]$$

$$b^* = 200\left[f\left(\frac{Y}{Y}\right) - f\left(\frac{Z}{Z}\right)\right]$$

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$$a^* = 500[f(\frac{X}{X}) - f(\frac{Y}{Y})]$$

$$b^* = 200[f(\frac{Y}{Y}) - f(\frac{Z}{Z})]$$

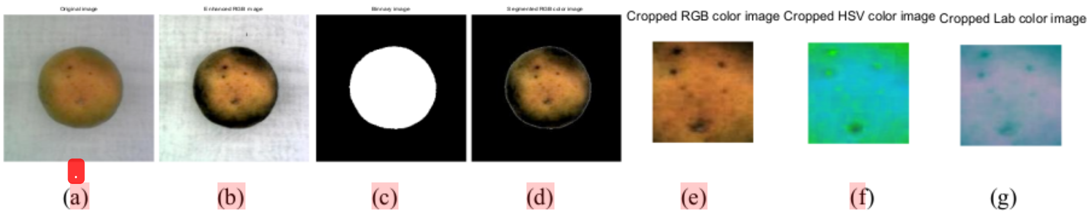

Figure 2. An example of image segmentation and color conversion processes: (a) original image, (b) contrast enhancement, (c) binary image, (d) color segmented image, (e) cropped RGB color image, (f) cropped HSV color image, and (g) cropped L*a*b* color image.

2.4. Data analysis

Data analysis employed in this research was correlation analysis between visual features of orange images and fruit quality parameters (weight, hardness and TSS). Results of the correlation analysis were then utilized to develop mathematical model to estimate changes of orange quality (*Q*) according to storage time (*t*) and temperature (*T*):

$$Q = f(t,T)$$

3. Results and Discussions

The changes of orange weight against storage time at room and cold temperature followed order-4 polynomial graph with mean squared errors of room and cold temperature treatment were 1.08 and 1.04, respectively. In addition, the changes of orange hardness against storage time at room and cold temperature followed order-3 polynomial graph with mean squared errors of room and cold temperature treatment were 0.0018 and 0.0086, respectively. However, the changes of orange TSS against storage time at room and cold temperature followed order-2 polynomial graph with mean squared errors of room and cold temperature treatment were 0.2682 and 0.0521, respectively. The actual changes of orange quality parameters against storage time are shown in Figure 3.

Orange weights stored in both room and cold temperature had a strong relationship with image area, which was indicated by the high value of $r^2 = 0.8197$ and $r^2 = 0.8291$, respectively (Figure 4). The visual parameter of image area, therefore, can be used as a parameter to estimate orange weight during storage. On the other hand, fruit hardness did not have a strong correlation with the visual parameters of the image as indicated by small correlation coefficients of various visual parameters of the image with the hardness of the orange. The biggest correlation coefficient only reached $r = 0.114$ from the relationship between the average hue value and hardness. TSS of oranges stored in room temperature had a fairly strong relationship with the average hue value of the HSV color model and the average chroma a* of the CIE-Lab color model with coefficients determination of $r^2 = 0.7473$ and $r^2 = 0.7029$, respectively.

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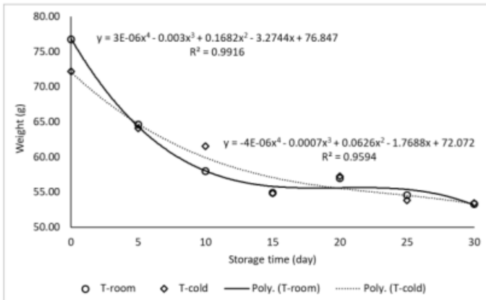
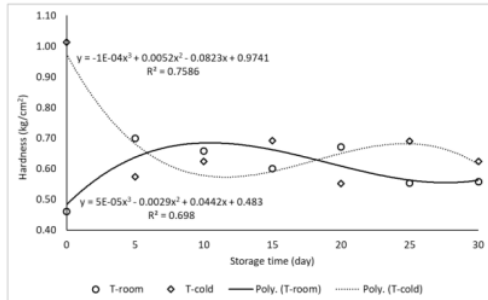
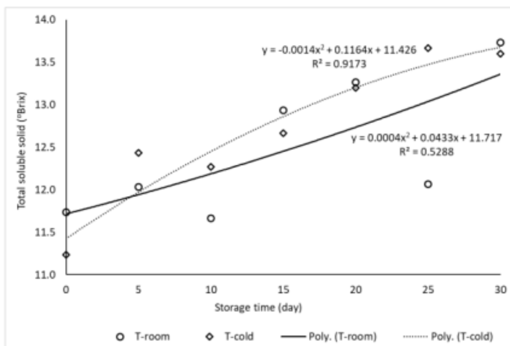


(a)



(b)



(c)

Figure 3. The changes of orange quality against time during storage in room and cold temperature: (a) weight, (b) hardness, and (c) total soluble solid.

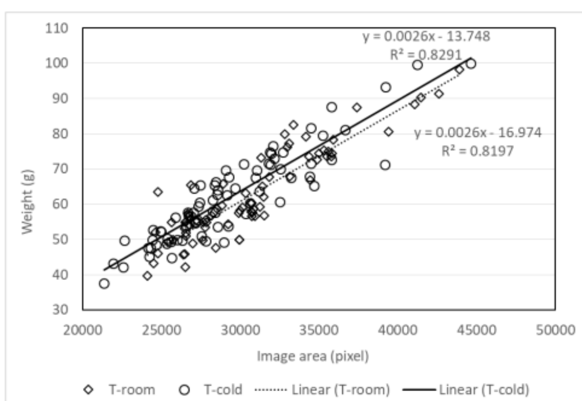
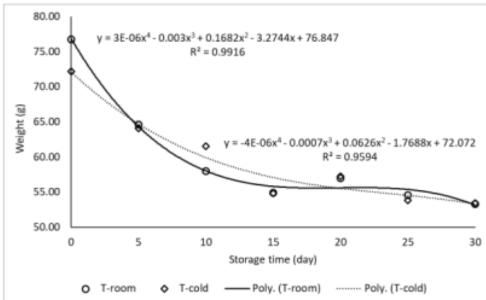
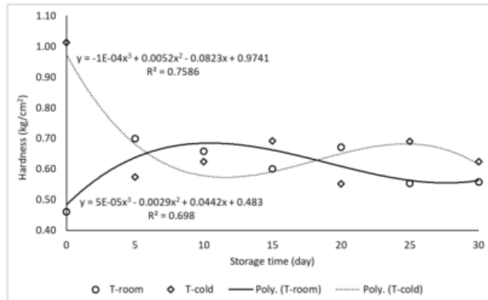


Figure 4. Correlation between orange weight and binary image area.



(a)



(b)

Figure 5. Correlation between orange total soluble solid and: (a) mean hue and (b) mean a*.

4. Conclusion

a. Binary area of orange image can be used to estimate changes in weight of orange fruits during storage.
b. None of visual parameters of orange images can be used to estimate the hardness of oranges because the correlation between them is very small.
c. TSS has a fairly strong relationship with the average hue value and the average chroma a* in room temperature storage.

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References

[1]. Aghistni F. 2008. Model Perpindahan Massa pada Mikrofiltrasi untuk Penghilangan Limonin dan Naringin dari Jus Jeruk Siam (*Citrus nobilis* var microcarpa) [disertasi]. Sekolah Pasca Sarjana. Institut Pertanian Bogor. Bogor.

[2]. Handoko, D. D., Napitupulu, B., dan Sembiring, H. 2000. Penanganan Pasca Panen Buah Jeruk. Balai Pengkajian Teknologi Pertanian Sumatera Utara, Medan.

[3]. Hulme, A.C. 1971. The Biochemistry of Fruit and their product. Vol. I. Academic Press, London.

[4]. Kamran, G., Youcef, G., and Ebrahimzadeh, M. A. 2009. Antioxidant activity, phenol and flavonoid contents of 13 citrus species peels and tissues. Pakistan Journal of Pharmaceutical Sciences. 22 (3): 277-281.

[5]. Kefford, J.F. Chandler, B.V. 1970. The Chemical Constituents of Fruits. Academic Press, New York and London.

[6]. Olabinjo, O.O., Ogunlowo, A.S., Ajayi, O.O., and Olalusi, A.P. 2017. Analysis of Physical and Chemical Composition of Sweet Orange (Citrus sinensis) Peels. International Journal of Environment, Agriculture and Biotechnology (IJEAB). 2(4): 2201-2206.

[7]. Pantastico, E. R. B, 1993. Fisiologi Pasca Panen. UGM-Press, Yogyakarta.

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[8]. Pracaya, 2000. Jeruk Manis, Varietas, Budidaya dan Pascapanen. Penebar Swadaya, Jakarta.

[9]. Rafiee, S., Jahromi, M.K., Jafari, A., Sharifi, M., Mirasheh, R., and Mobli, H. 2007. Determining Some Physical Properties of Berganot (citrus medica). International Agrophysics. 21: 293-297.

[10]. Saputera, Sutrisno., S. Susanti dan I. W. Budiastra, 2000. Pengkajian Penyimpanan Jeruk Besar (Citrus grandis L) Pengolahan Minimal dengan Kemasan Atmosfer Termodifikasi. Buletin Keteknikan Pertanian.

[11]. Simbolon, F. P. M., 2008. Pengaruh Konsentrasi Emulsi dan Lama Penyimpanan Terhadap Mutu Buah Jeruk Manis (Citrus Sinensis, Linn). USU-Press, Medan.

[12]. Ting, S.V. dan J.A. Attaway. 1971. Citrus Fruit. in Hulme, A.C. The Chemical Constituents of Fruits.
[13]. Academic Press, New York and London.

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