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DETECTION OF ORANGE COLOR USING IMAGING ANALYSIS

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Abstract

The objective of this study is to propose a computer vision and image analysis program to fined of essay and suitable technique for external fruit inspection and predicting orange fruits maturity through the color analysis of images samples which evaluated by Envi program. Also tests the relationships between R/G ratio band, average of RGB bands and VARI indices with chlorophyll a&b and carotenoids were determined by spectrophotometer used absorption of wave length 470, 645 and 662 nm. The research revealed that:
-The computer vision and image analysis program could be used to differentiate orange properties;
-The results showed there are response between chlorophyll and carotenoids of orange fruits;
-R/G band, average of RGB and VARI indices showed a sensitive band ratio to different orange properties such as chlorophyll and carotenoids.

Key words: *carotenoids, computer vision, orange, RGB color bands.*

INTRODUCTION

The citrus industry is an important component the Egyptian National income. Harvested orange area in Egypt are 101421 (Ha) and the production are 2577720 tones (FAO, 2013). Color is the most important features for accurate classification of citrus by using machine vision comes in to play the important role of quality control for agricultural products. (Raji and Alamutu, 2005) reviiewed the recent development and application of image analysis and computer machine vision in sorting of agricultural materials and products in the food industries.

(Wanitchang et al., 2010) showed that a common destructive method for measurement of the maturity and growth of Dragon fruit is to analyze its total soluble solids, total acid, ratio of total soluble solids and total acidity and weight ratio were transformed into a principal component and it used to represent a single maturity index. (Ismail and Razali, 2012) showed that color vision systems have been found more effective in color inspection. A color camera output can be de-coded into three images to represent the red, green and blue (RGB) components of the full image. The three components of the color image can be recombined in software or hardware to produce intensity, saturation and hue images, which can be more convenient for subsequent processing. Color is considered a fundamental physical property of agriculture products and foods. (Ahmad et al., 2010) found that the analysis of the area of citrus related to its size, and the skin color in RGB color model related to sweetness and ripeness of citrus were conducted. The relationship of the area of the object and the weight of citrus was analyzed as well as the fruit color, the sweetness checked by refract meter. (Khojastehnazhand et al., 2010) showed that an image processing based technique was developed to measure volume and mass of citrus fruits such as lemons, limes, oranges, and tangerines. The technique uses two cameras to give perpendicular views of the fruit coefficient of determination (R^2) for lemon, lime, orange, and tangerine were 0.962, 0.970, 0.985, and 0.959, respectively. The characterization results for various citrus fruits showed that the volume and mass are highly correlated.

So in this research to test a simple and suitable technique for predicting orange fruits maturity, also study the relationships between R/G ratio band and average of RGB bands and

chlorophyll a&b and carotenoids at different maturity days.

MATERIALS AND METHODS

The present work aimed to predict orange properties using image analysis. The experimental work was undertaken at a private farm in Wadi Elnetron, Bohira Province, Egypt in winter season of 2011.

The results revealed that, some chemical properties of orange fruits.

Orange *(Citrus aurantum)* fruits samples were collected for identifying different biochemical measurements including concentration of chlorophyll *a* and *b* and carotenoids.

Computer vision consists of imaging box with black color connected with digital camera 16.4 Megapixels. The camera were mounted about 25 cm the position of the lighting was adjusted to provide uniform, well illuminated and free from shadows images of fruit.

Captur cards (WinFast DV2000 with a resolution of 320H X 240V), an appropriate lighting system and a personal computer.

Image Analysis system: orange samples were captured by the camera, transferred to the PC through the capture card, digitized, and stored on the PC in using Envi programme to analyze the images of orange fruits for three band RGB (red, green, blue) color space.

Color evalutation: Using the most popular color model RGB color space. The color was presented with R, G and B, the amount of information is tripled. RGB system is sensitive to lighting or other conditions to evaluate the color of captured images of fruit, the acquired RGB color information was transformed to:

The average intensity defined (Abdesselam and Abdullah, 2000) as I= (R + G +B)/3

Red/ Green ratio Blasco et al. (2009), uses a threshold on the R/G ratio and (Gitelon et al., 2002) calculated Visible Atmospheric Resistant Index (VARI) as follows:

$$VARI = \frac{green - \mathrm{Re}\, d}{green + \mathrm{Re}\, d - blue}$$

Spectrophotometer Spectrophotometer has arranged 390 to 900 nm was used for measuring the absorption of wave length 470, 645 and 662 nm to determine chlorophyll and carotenoids. The amounts of carotenoids were calculated according to the following equations (Dere et al., 1998):

Chl,a = 11.75 A_{662} – 2.35 A_{645}

Chl,b = 18.61 A_{645} – 3.96 A_{662}

Carx+c = (1000 A_{470} – 2.27 Chl, a – 81.4 Chl, b) / 227)

RESULTS AND DISCUSSIONS

The computer vision and image analysis program could be used to differentiate orange properties. The results show the relationships between R/G ratio band, average intensity of RGB and *VARI indices* and chlorophyll a&b and carotenoids at different maturity days. Results in (Figure 1) show that during maturity time increasing the carotenoids increases from 4.80 to 15.77 mg/100 g, while decreased chlorophyll a&b from 1.92 to 0.72, from 3.01 to 1.18 mg/100 g, respectively.

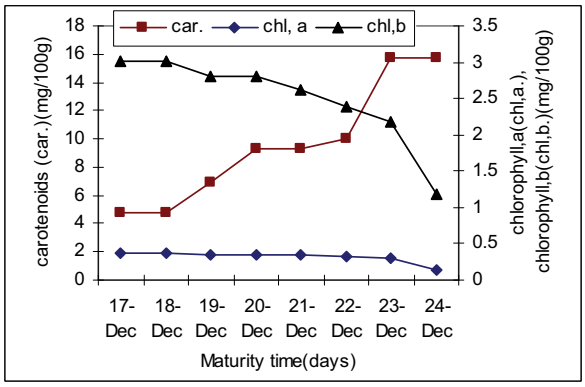
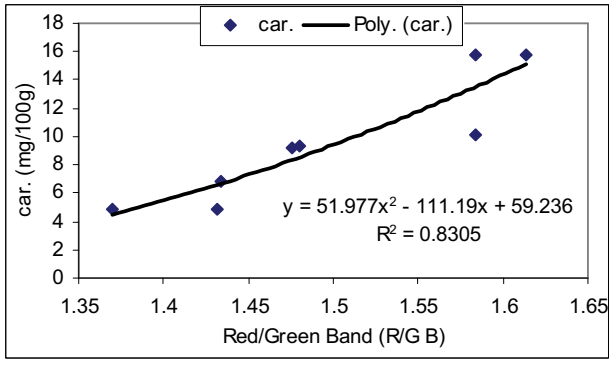
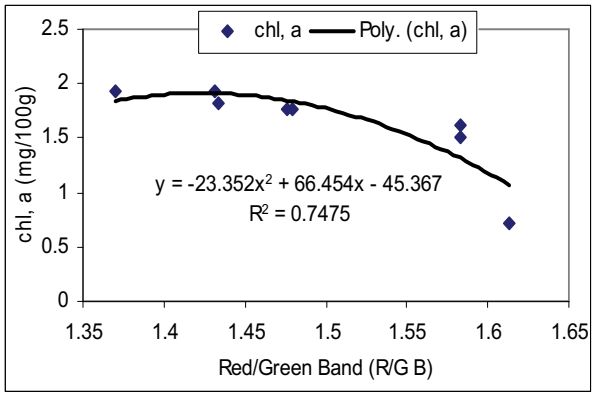


Figure 1 .The relationships between the maturity time (days) and chlorophyll, a&b carotenoids

There are the relationships between Red/Green ratio band and chlorophyll a&b also with carotenoids concentrations shown in (Figure 2) when carotenoids increased from 4.80 to 15.77 mg/100 g increased Red/Green ratio band 1.36 to 1.61, while chlorophyll a&b decreased from 1.92 to 0.72 and from 3.01 to 1.18 of mg/100 g, respectively.





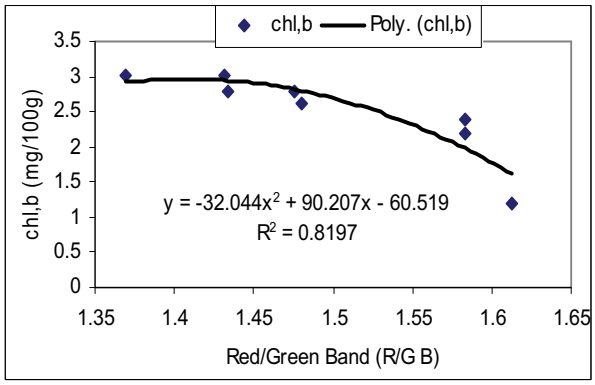


Figure 2. The relationships between the Red/Green ratio band and chlorophyll, a&b and carotenoids

The following equation forms were satisfied for predicting chlorophyll, a&b and carotenoids by Red/Green ratio band during maturity time

$y = 51.977x^2 - 111.19x + 59.236 \quad R^2 = 0.83$

$y = -23.352x^2 + 66.454x - 45.367 \quad R^2 = 0.74$

$y = -32.044x^2 + 90.207x - 60.519 \quad R^2 = 0.81$

Also the same trend in (Figure 3) the data showed there are the relationships between average intensity of RGB and chlorophyll a&b and carotenoids concentrations. The carotenoids increased from 4.80 to 15.77 mg/100g increased average intensity of RGB from 126.49, to 147.06. In contrast, chlorophyll a&b decreased from 1.92 to 0.72 and from 3.01, to 1.18 of mg/100 g, respectively.

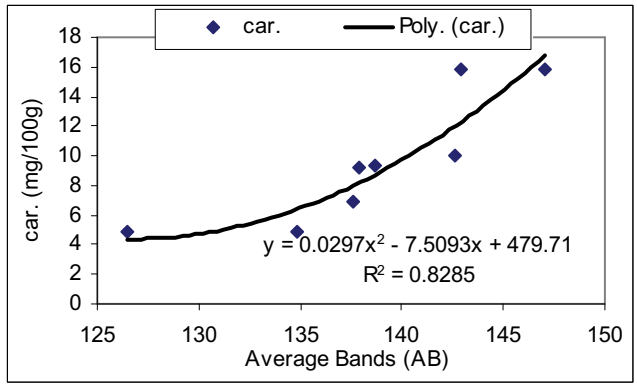
The following equations were satisfied for predicting average intensity (RGB) bands with chlorophyll, a&b carotenoids (mg/100 g)

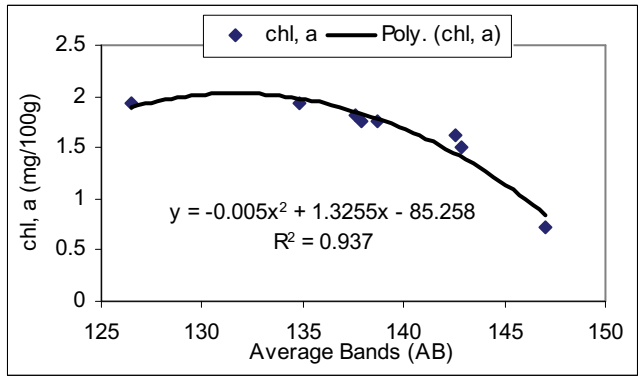
$y = 0.0297x^2 - 7.5093x + 479.71 \quad R^2 = 0.82$

$y = -0.005x^2 + 1.3255x - 85.258 \quad R^2 = 0.93$

$y = -0.0073x^2 + 1.9022x - 121.52 \quad R^2 = 0.97$

(Figure 4) shows similar trends as the data showed relationships between VARI indices and carotenoids concentration.





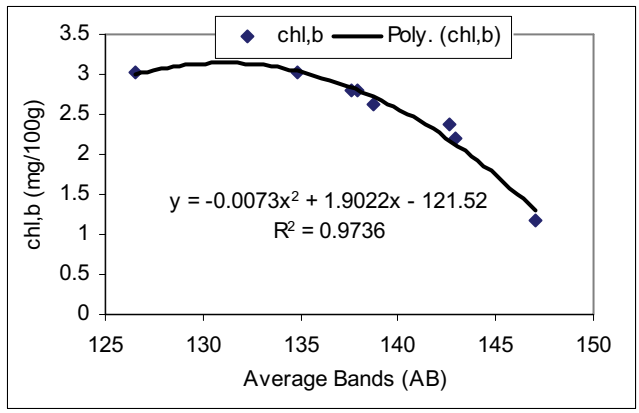
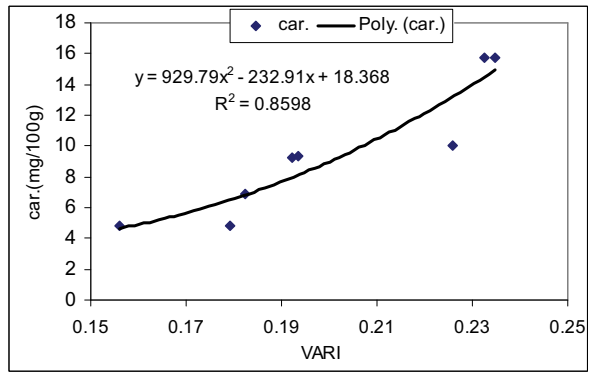
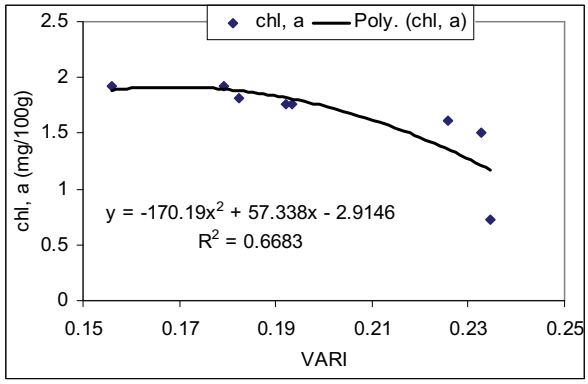


Figure 3. The relationships between the average (RGB) bands and band and chlorophyll, a&b and carotenoids

Carotenoids increased from 4.80 to 15.77 mg/100 g while VARI increased from 0.155 to 0.234 when chlorophyll a&b decreased from 1.90 to 0.72 mg/100 g and from 3.01 to 1.18 mg/100 g, respectively.





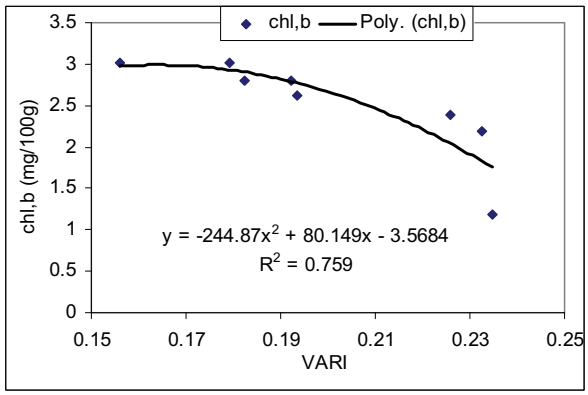


Figure 4 .The relationships between VARI indices and carotenoids and chlorophyll, a&b of orange fruits

The following equation forms were satisfied for predicting average intensity (VARI) bands with chlorophyll, a and b and carotenoids (mg/100 g):

$y = 929.79x^2 - 232.91x + 18.368 \quad R^2 = 0.8598$

$y = -170.19\,x^2 + 57.338x - 2.8148 \quad R^2 = 0.6683$

$y = -244.87x^2 + 80.149x - 3.5684 \quad R^2 = 0.759$

CONCLUSIONS

An image analysis technique was found to serve as a suitable and accurate method for external orange fruit inspection. Relationships were determined between R/G ratio band, average of RGB bands and VARI index with chlorophyll a and b and carotenoids. Multiple regression analysis and correlation coefficient tested the association between chlorophyll a and b and carotenoids and different band ratios including R/G ratio and average of RGB bands to identify the optimum index sensitive to maturity. The results demonstrated that the average R/G band ratio, and average RGB and VARI indices provide a better indication of chlorophyll a and b and carotenoids concentrations.

The coefficient of determination for all properties of R/G band ratio and VARI indices were less than those with average of RGB.

REFERENCES

Abdesselam, Abdelhamid, Abdullah, Rahmat Choo 2000. Pepper berries grading using artificial neural networks. In TENCON 2000. Proceedings, 2, p. 153-159.

Ahmad U., Mardison Tjahjohutomo R., Nurhasanah A., 2010. Development of automatic grading machine prototype for citrus using image processing. Australian Journal of agricultural Engineering 1(5), p. 165-169.

Blasco J., Cubero S., Gómez-Sanchís J., Mira P., Moltó E., 2009. Development of a machine for the automatic sorting of pomegranate (*Punica granatum*) arils based on computer vision. Journal of Food Engineering, 90, p. 27-34.

Dere S., Günes T., Sivaci R., 1998. Spectrophotometric determination of chlorophyll a, b and total carotenoid contents of some algae species using different solvents. Tr. J. of Botany 22: p. 13-17.

FAOSTAT, 2013. orange production. Available from /http://faostat.fao.orgs.

Gitelson A., Kaufman Y., Stark R., Rundquist D., 2005. Novel algorithms for remote estimation of vegetation fraction. Remote Sensing of Environment, 80, p. 76-87.

Ismail W., Razali M., 2012. Machine Vision to Determine Agricultural Crop Maturity. Trends in Vital Food and Control Engineering. ISBN 978-953-51-0449-0, p. 115-124.

Khojastehnazhand M., Omid M., Tabatabaeefar A., 2010. Development of a lemon sorting system based on color and size. African Journal of Plant Science, 4(4), p. 122-127.

Raji A., Alamutu A., 2005. Prospects of computer vision automated sorting systems in agricultural process operations in Nigeria. Agric. Eng. Int.: the CIGR J. Sci. Res. Dev. 7, p. 1-12.

Wanitchang J., Terdwongworakul A., Wanitchang P., Noypitak S., 2010. Maturity sorting index of dragon fruit: Hylocereus polyrhizus. Journal of Food Engineering, 100, p. 409-416.