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PREDICTION OF STRAWBERRY CHEMICAL COMPOSITION BY IMAGING ANALYSIS PROCESSES

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Abstract

The goal of this research is to analyze images of strawberry fruits and related the results with chemical properties under using different applications of gibberellic acid and citrate potassium. The work was carried on spring 2016 at private farm in Tanta ELgharbia governorate, Egypt. The chemical properties such as the total soluble solid and anthocyanin was determined under different treatments and related with images indices. The ENVI software package was used to analyze the images of orange fruits and three bands, RGB, (red, green, blue) were derived for each image until obtaining the R, G, B colors then color indices Red/ Green ratio (R/G), hue, intensity (I). The results showed that there are significant correlation with some chemical and color indicators. The results obtained in this research demonstrated that hue, intensity and R/G ratio indices gives understanding about and total soluble solid and anthocyanin.

Key words: *prediction, chemical properties, strawberry, colour parameters and gibberellic acid*

INTRODUCTION

Strawberry (Fragaria x ananassa Duch) is one of the most popular vegetable crops. In Egypt, it occupies an important position among the untraditional vegetable crops due to its multifarious use as local fresh consumption, food processing and exportation, Also it is a very rich source of bioactive compounds including vitamin E, vitamin C, b-carotene and phenolic compounds (phenol acids, flavan-3-ols, flavonols, and anthocyanins. Strawberry are valued for to their antioxidant content. Egypt ranked the fourth on the world in Strawberry production. Harvested area of strawberries in Egypt are 6,029 (Ha), yield 422,825 Hg/Ha in 2013 [4]. Strawberry are famous vegetable consumed freshly and as processed food in Egypt. The fruits were harvested in immature stage based on the fruit size and skin color. The mineral nutrition, as well as the cultivar, climatic conditions, agronomic practices and water supply, directly influences the quality of strawberry [14].

Biofertilization method plays an important role in the plant nutritional requirements. Whereas, biofertilizers enhance crop productivity through nitrogen fixation, phosphate solubilization, plant hormone production, ammonia excretion and controlling various plant diseases Strawberries are a good source of ascorbic acid (AA), anthocyanin's and flavone's and, among the fruits, they have one of the highest antioxidant activities evaluated by oxygen radical absorbance capacity [3].

The sum of red, green and blue colour (R+G+B) intensities and the ratio of $((G+B-R)/(R+B+G))^2$ were strongly correlated (R^2=0.95 and 0.89 respectively) with the total solid content of strawberry fruits. This two indices could be used to decide the correct maturity stage of the strawberry fruits. With reducing the values of these indices, increase the TSS of fruits. Consequently, the lowest values of indices indicates the highest total solid contents in fruits [1].Potassium (K) is also highly demanded by the crop for directly favoring fruit quality and increasing the contents of total soluble solids and ascorbic acid, besides improving aroma, taste, color and firmness of fruits [11]. Physical and chemical properties of the cultivar ‘Aromas’, such as external color, titratable acidity, pH and soluble solids, were influenced by combined doses of N and K applied through fertigation [12]. Like anthocyanins, the amount of AA is also dependent on the strawberry cultivar and ripening degree, although the average content (60 mg/100 g) is high enough to consider strawberry as one of the richest sources of AA among fruits. Multispectral imaging is used to detect pigment concentration and soluble solid (sugar) in fruits [10]. Colour is one of the most important attributes in fruits and vegetables because it directly influences the consumer decision to accept or reject a particular product. Thus producers strive to prevent colour defects in the products that reach the market, and to ensure that the different batches of products (for example canned, bagged, etc.) show similar colours. In the industry, colour is measured using a colorimeter [8]. The relationships between different maturity time and total soluble solid (Tss), pH, acidity, percentage of liquid, and (TSS/acidity), during maturity time increasing the total soluble solid (TSS), pH, percentage of liquid and (TSS/acidity) increased from 8.20 to 10.06 (Brix, %), from 2.84 to3.07 from 41.54 to 49.83 % and from 6.7 to 9.00 respectively while decreased acidity from 1.25 to 1.07 % [6].There are significant correlation between RGB, hue and saturation indices and some chemical properties such as total soluble solid (Tss), ph, acidity and percentage of liquid of orange fruits [5]. Hue, intensity, saturation and VARI index with some chemical properties which changes such as acidity, percentage of liquid, ph, total soluble solid (tss), tss/acidity, chlorophyll a, chlorophyll b and also carotenoids concentration at different maturity days. [13].

MATERIALS AND METHODS

This work were carried out at private farm in Shoni, Tanta, ELgharbia governorate, Egypt during March and April 2016 to measure some chemical and color properties of strawberry fruits underusing two applications of gibberellic acid (GA_3) and one application of three applications of citrate potassium (c.p.) through 12 different treatments as follows in Table. 1.

(1)-Fruit chemical properties

Different chemicals of fruits were determined before and after the applications of nutrition

-The (Total soluble solid) tss was estimated from a single digital refractometer reading taken from the combined juice extracted from the fruit.

- Anthocyanin was determined in the peels as (mg/ 100 g) by using extraction solution contains 85 ml ethyl alcohol 95 %+ 15 ml HCl 1.5 N that was added to 4 g fresh berry peel. The mixture was left for at least 24 h, then 2 ml of the filtrate was used to determine the optical density at 535 nm [7].

Table 1. The plant case and applications treatment

Plant		Applications Treatment
A	Mothers only	0 ppm (GA_3)+ 0 gm/5L (c.p.)
B		0 ppm (GA_3) +1.25 gm/5L (c.p.)
C		0 ppm (GA_3) +2.5 gm/5L (c.p.)
D		25 ppm (GA_3) + 0 gm/5L (c.p.)
E		25 ppm (GA_3) +1.25 gm/5L(c.p.)
F		25 ppm (GA_3) +2.5 gm/5L (c.p.)
G	Mothers which found with 5 runners	0 ppm (GA_3) + 0 gm/5L (c.p.)
H		0 ppm (GA_3) +1.25 gm/5L (c.p.)
I		0 ppm (GA_3) +2.5 gm/5L (c.p.)
J		25 ppm (GA_3) + 0 gm/5L (c.p.)
K		25 ppm (GA_3) +1.25 gm/5L(c.p.)
L		25 ppm (GA_3) +2.5 gm/5L (c.p.)

Computer visioning system

The system consisted of an imaging box with non-reflective black cloth connected to a digital camera of 16.4 Megapixels. The camera was mounted at 25 cm from the bottom of the imaging box. The position of the two light sources was adjusted to provide uniform light intensity. Images were taken to capture images of fruit free from shadows. Following capturing images, they stored on a personal computer for the analysis. Capture cards (WinFast DV2000 with a resolution of 320H X 240V). A personal computer was used for analyzing the images.

Image Analysis system

Strawberry fruit samples were captured by the camera, transferred to the PC through the capture card, digitized, and stored on the PC. The ENVI software package was used to analyze the images of orange fruits and three bands, RGB, (red, green, blue) were derived for each image until obtaining the R, G, B colors then color indices Red/ Green ratio (R/G), hue, intensity (I) as shows in fig. 1 and three bands, RGB, (red, green, blue) were derived for each image until obtaining the R, G, B colors then color indices Red/ Green ratio (R/G), hue, intensity (I) as shows in fig. 2 the whole procedure followed until obtaining the R, G, B colors and indices.

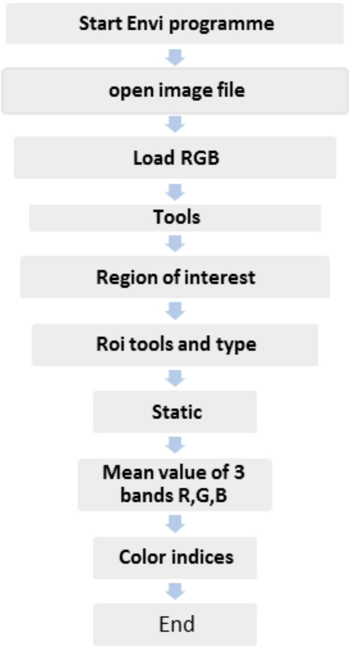

Fig. 1. The steps to produce (R, G, B colors) by ENVI software

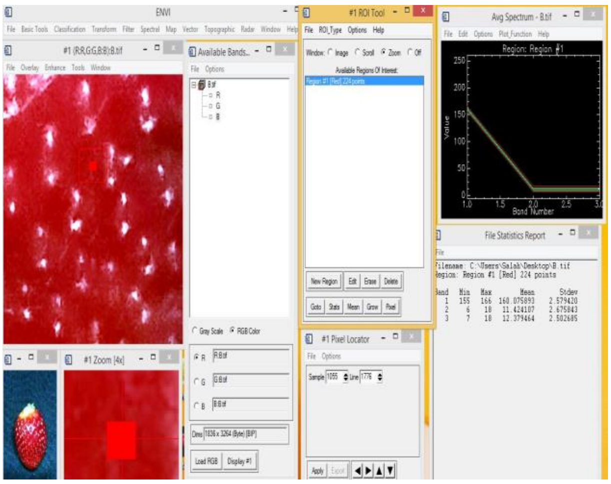

Fig. 2. A window of ENVI programme showing the spectral signature and associated statistics obtained from a strawberry fruit

(2)-Fruit color properties

Red/ Green ratio (R/G) according to [2], hue and intensity (I) according to the following equations [9]

$$H = COS^{-1}\left\{\frac{(2R-G-B)/2}{\left[(R-G)^2+(R-B)(G-B)\right]^{1/2}}\right\}$$

$$I = \frac{1}{3}(R+G+B)$$

RESULTS AND DISCUSSIONS

During strawberry fruits ripening its color change from green, light red and then after full maturity reached to dark red color while anthocyanin is produced and starts to increase and disappeared other pigments. The computer vision and image analysis program used to differentiate chemical strawberry properties.

The results in fig. 3 showing that the high value of hue was 0.66824 in treatment (D) and the low value was 0.27443 in treatment (K) while the minimum and the maximum value of anthocyanin were 7.298031 mg/100gm in treatment (K) and 22.99728 mg/100gm in treatment (D).

The results in fig. 4 showing that the high value of hue was 1.282715 in treatment (D) and the low value was 0.906227 in treatment (H , K) and the low and the high value of (total soluble solid) tss were 4.3 (Brix,%) in treatment (K) and 8.2 (Brix,%) in treatment L.

The results in fig. 5 showing that the high value of intensity was 132.5062 in treatment (C) and the low value was 64.06764 in treatment H while the minimum and the maximum value of anthocyanin were 7.298031mg/100gm in treatment (K) and 22.99728 mg/100gm in treatment (D) .

The results in fig. 6 showing that the high value of intensity was 140.84 in treatment (A) and the low value was 50.1087 in treatment (J) and the low and the high value of (total soluble solid) tss were 5 (Brix,%) in treatment B and 7.6 (Brix,%) in treatment(L).

The results in fig. 7 showing that the high value of R/G ratio was 1.055226 in treatment (I) and the low value was 0.93.527 in treatment (A) while the minimum and the maximum value of anthocyanin were 1.026816 mg/100gm in treatment (A) and 13.06657 mg/100gm in treatment (K).

The results in fig. 8 showing that the high value of R/G ratio was 2.416913 in treatment (H) and the low value was 1.082603 in treatment (C) and the low and the high value of (total soluble solid) tss were 4 (Brix,%) in treatment (C) and 7.6 (Brix,%) in treatment (L).

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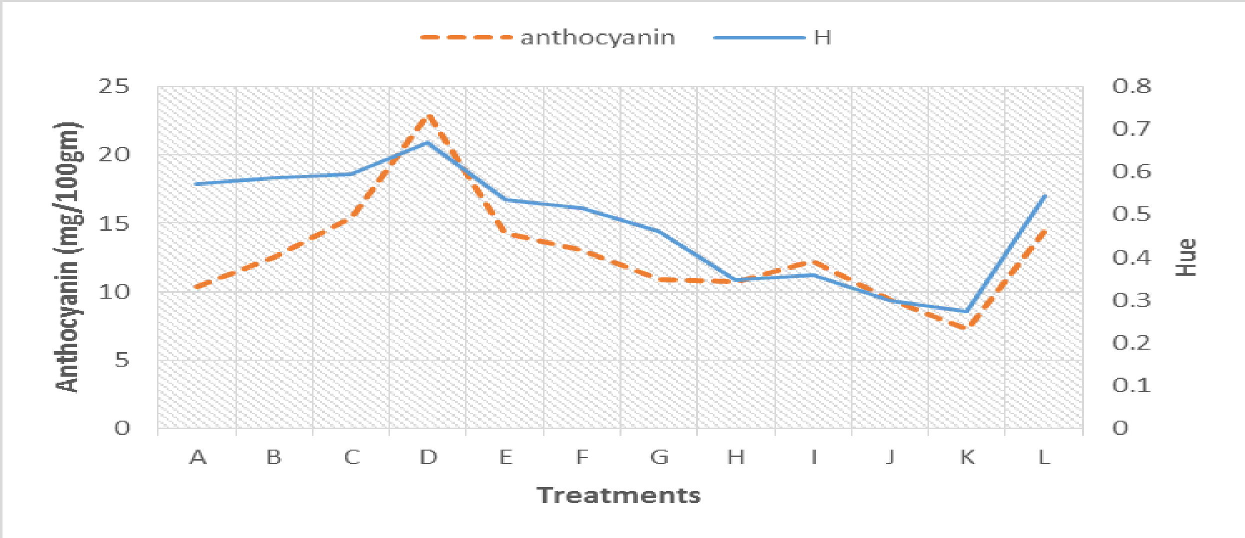

Fig. 3. Effect of gibberellic acid and citrate potassium on anthocyanin and hue during strawberry maturity

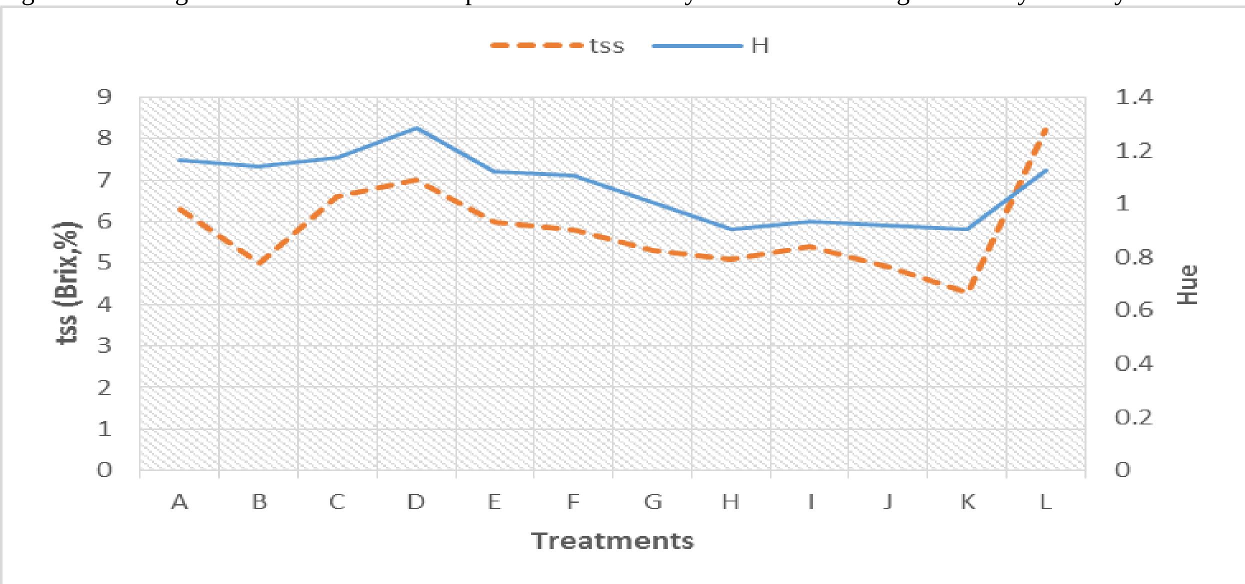

Fig. 4. Effect of gibberellic acid and citrate potassium on tss and hue during strawberry maturity

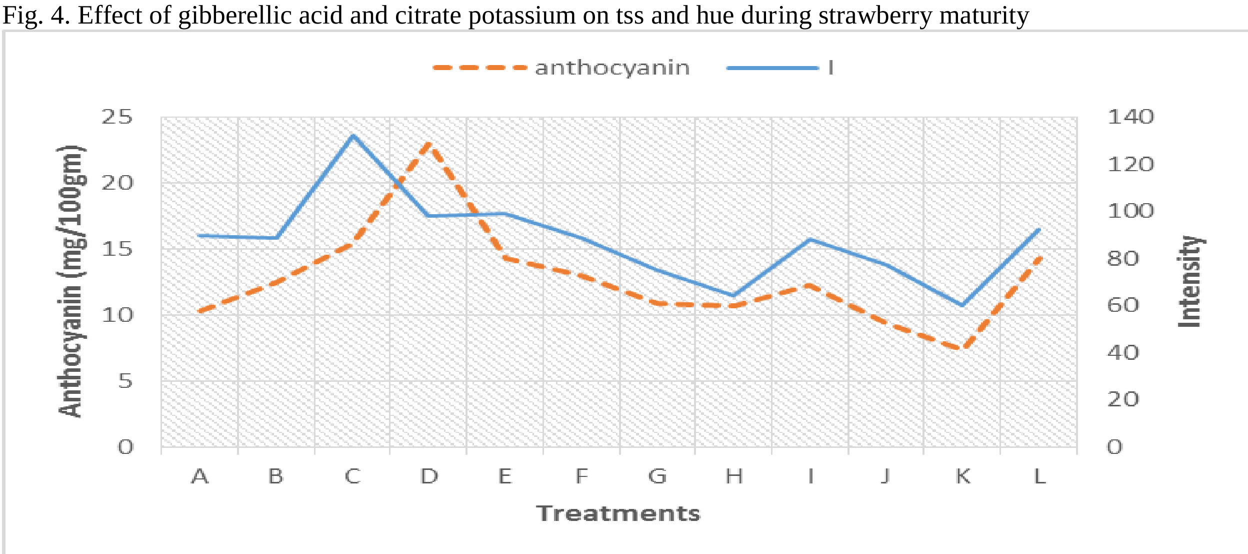

Fig. 5. Effect of gibberellic acid and citrate potassium on anthocyanin and intensity (I) during strawberry maturity

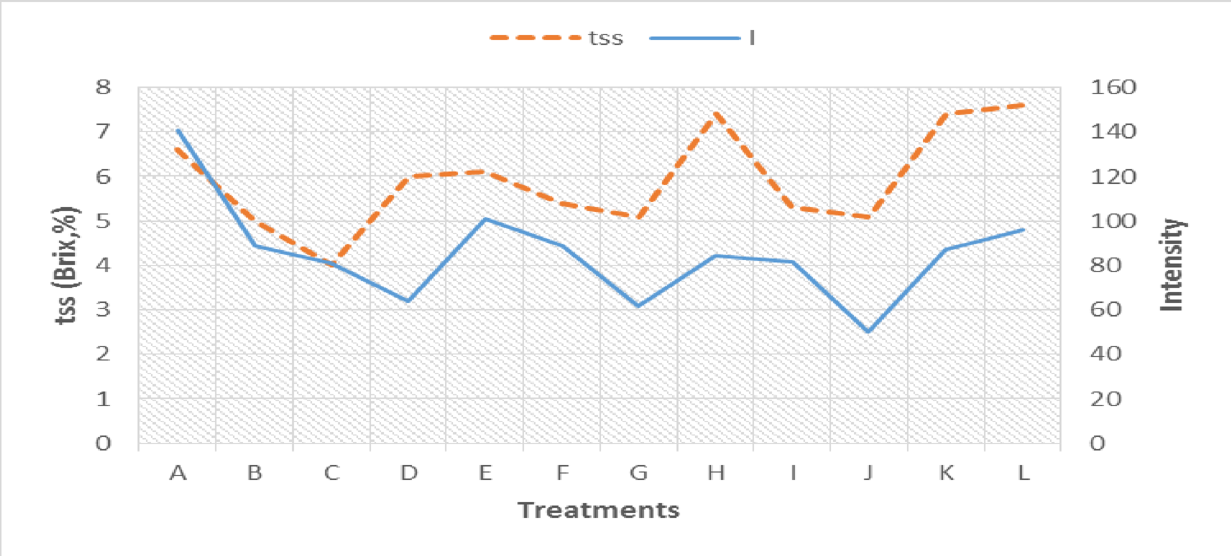

Fig. 6. Effect of gibberellic acid and citrate potassium on tss and intensity (I) during strawberry maturity

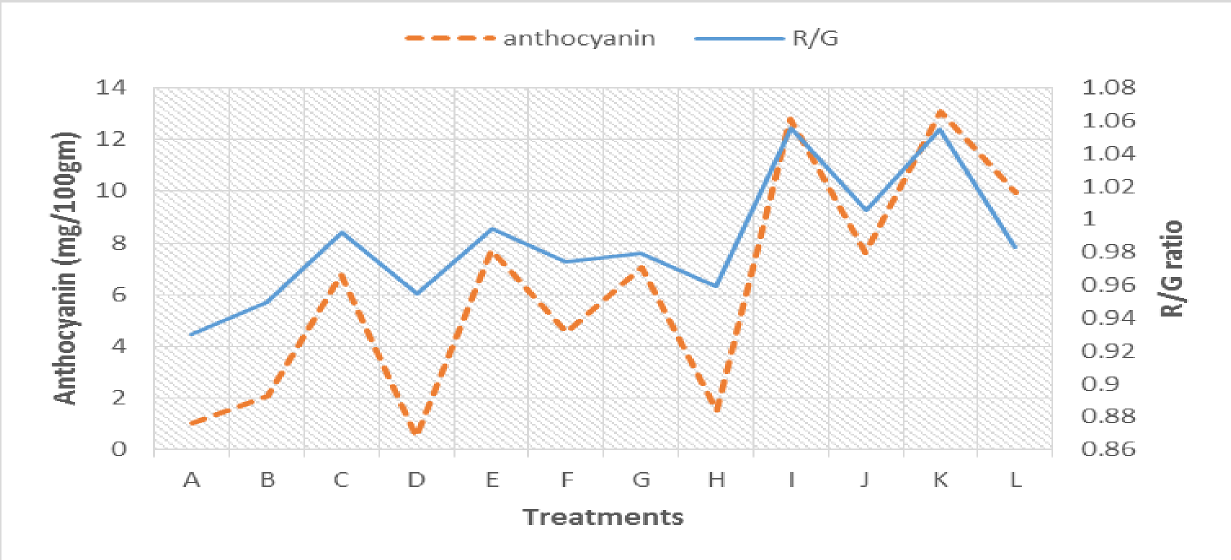

Fig. 7. Effect of gibberellic acid and citrate potassium on anthocyanin and (R/G) ratio during strawberry maturity

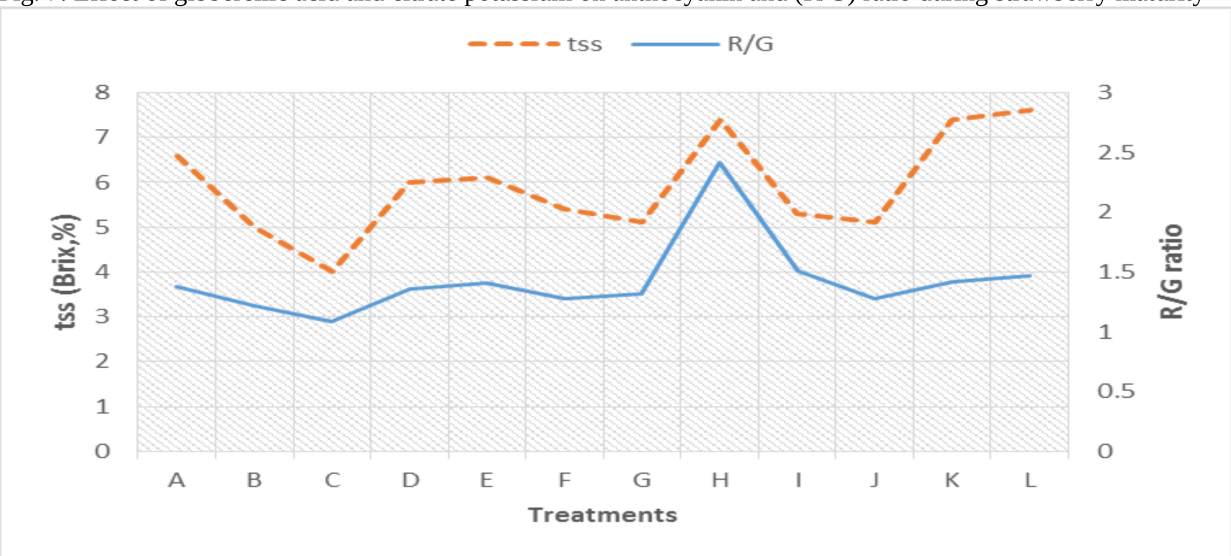

Fig. 8. Effect of gibberellic acid and citrate potassium on tss and (R/G) ratio during strawberry maturity

CONCLUSIONS

The results obtained in this research demonstrated that hue, intensity and R/G ratio indices gives understanding about and total soluble solid (tss) and anthocyanin.

-Intensity provide a better indication of total soluble solid (tss).

-With 25 ppm gibberellic acid +2.5 gm/5L citrate potassium was the highest value to total soluble solid (tss) as follow 8.2(Brix,%).

-With 25 ppm gibberellic acid + 0 gm/5L citrate potassium there were the same highest value of anthocyanin as follow 22.99728 mg/100gm.

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