Study of Effect Different of Ozone Doses on Sugars Content in Tomatoes at Different Stages of Ripening

Milad. A. Shalluf

***Abstract*—**The determination of sugars in foods is very significant. Their relation in fact, can affect the chemical and sensorial quality of the matrix (e.g., sweetness, pH, total acidity, microbial stability, global acceptability) and can provide information on food to optimize several selected technological processes. Three stages of ripeness (green, yellow and red) of tomatoes (Lycopersicon Esculentum cv. Elegance) at different harvest dates were evaluated. Fruit from all harvests were exposed to different of ozone doses (0.25, 0.50 and 1 mg O3/g tomatoes) and clean air for 5 day at 15 °C±2 and 90-95 % relative humidity. Then, fruits were submitted for extraction and analysis after a day from the finish of exposure of each stage. The concentrations of the glucose and fructose increased in the tomatoes which were subjected to ozone treatments.

***Keywords*—**Post-harvest Treatment, Controlled Atmosphere Storage, Ozone, Tomatoes, Glucose, Fructose

I. Introduction

SUGARS, as natural food ingredients, have a role in ascorbic acid stability [1].In general foods containing ascorbic acid usually are characterized by high carbohydrate content. Peppers have high vitamin C content [2] and a high sugar concentration. Concentrations of glucose and fructose increased significantly with maturation, with the red peppers fruits having the highest levels as reported by[3]. On the other hand, sucrose decreased with maturation to non-detectable levels in red peppers [4].

The general trend observed during the storage of tomatoes was an initial increase followed by a decrease during the later stage of storage. A particularly pronounced increase occurred with the appearance of yellow pigmentation. The increase in reducing sugars could be due to the breakdown of polysaccharides into water soluble sugars such as glucose, fructose and sucrose. However, as storage time advances, reducing sugar content declined [5]. Sugar content of tomatoes was also affected by storage temperature. A considerable decrease in the reducing sugar content was found in tomatoes stored at ambient conditions. Sugar was better maintained in tomatoes stored under a cooled environment [5], [6] also reported that reduced temperature storage reduced fruit metabolism, particularly respiratory activity, delaying the ripening process and increasing the fruit shelf life. [7] found that total sugar content was increased with the advancement of ripeness irrespective of the maturity condition.

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The highest quantity of total sugar (4.03%) was recorded in fully ripened tomatoes, while it was the lowest quantity (3.30%) in mature green tomatoes on the 12th day of storage. Ripening conditions were found to be affected significantly on the total sugar content of tomatoes at different storage durations. In strawberries, it was found that sucrose content decreased with storage time from an initial value of 19.9 mg/g of fresh weight on day 0 to about 45% at the end of shelf life (day 7) in both ozone treated and non-treated fruits. A decrease in sucrose content and an increase in glucose and fructose levels were observed from day 0 to day 5 [8].

II. Material and Methods

A. Ozonation Samples

Three stages of ripeness (green, yellow and red) of tomatoes (Lycopersicon Esculentum cv. Elegance) at different harvest dates were evaluated. Fruit from all harvests were exposed to (0.25, 0.50 and 1 mg O3/g tomatoes) and clean air for 5 day at 15 °C±2 and 90-95 % relative humidity. Then, fruits were submitted for extraction and analysis after a day from the finish of exposure for each stage.

B. Extraction and Assay

For these enzymatic assays, sample preparation is simple and the only apparatus required is a spectrophotometer. Glucose and fructose were analysed using a commercially available kit (Nr.10 716 260035) from R-Biopharm AG, Germany. Contents of bottle 1 were dissolved with 10 ml of redistilled water. Contents of bottle 2 were dissolved with 45 ml redistilled water. Contents of bottle 3 and 4 were used undiluted.

The tomatoes were crushed with a household blender. 50 g was weighed and placed into 250 ml flask. Distilled water was added and the mixture warmed in a water bath at 60 oC for 15 min. The mixture was then allowed to cool, and filtered through a membrane. The filtrate was diluted ten fold (it means all together 50 folds) for recommendations for methods. For the sugar test, 100 microliter was measured in a pipette for glucose, and 100 microliter for sucrose into two cuvettes. The process was continued as mentioned in the instructions used for fruits, the time recommended by the procedure for enzymatic reaction with glucose and Fructose in fruit is between 10-15 min for the extract diluted 60 fold, the experiments was conducted using UV spectrophotometry.

C. Statistical Analysis

The data were analyzed using the Statistical Analysis System (SAS) The General Linear Model procedure of ANOVA in the MINITAB software (version 15) (2000) was used to determine the effect of treatments on the dependent variables. Means were separated by the least significant difference (LSD) test for experiments. Each batch (9 tomatoes) from every experiment was divided in to 3 parts (3 x 3 tomatoes); each fraction was extracted separately. The extract was then analysed in duplicate which resulted in a total of 6 batches.

III. Results and Discussion

A. Effect of Different Ozone Doses on Glucose Content in Tomatoes at the Green Stage of Rripeness

The highest value of glucose in green tomatoes was in the fruits exposed to ozone in a dose of 0.50 mg/g (14.83 g/kg) followed by fruits stored under ozone enriched atmosphere of 0.25 mg/g (13.88 g/kg) and 1.00 mg/g (12.69 g/kg). Concentration of glucose in the untreated tomatoes (air) was 12.00 g/kg (Figure 1).

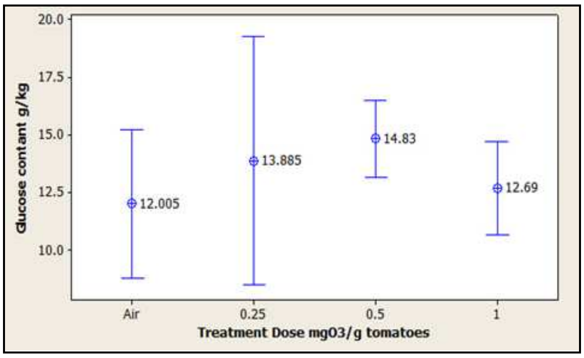

Fig. 1 Plots of glucose concentration (g/kg green tomatoes) vs ozone treatment doses

B. Effect of Different Ozone Doses on Glucose in Tomatoes at the Yellow Stage of Ripeness

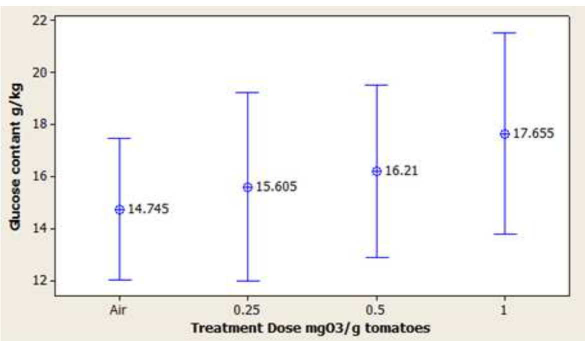

Fig. 2 Plots of glucose concentration (g/kg yellow tomatoes) vs ozone treatment doses

Concentrations of glucose in tomatoes at the yellow stage increased under exposure to ozone and with the increase in ozone dose. The values recorded were 14.74, 15.60, 16.21 and17.65 g/kg for the treatments 0, 0.25, 0.50 and 1.00 mg of ozone per gram of tomatoes (Figure 2).

C. Effect of Different Ozone Doses on Glucose in Tomatoes in the Red Stage of Ripeness

The concentration of glucose in the red stage tomatoes was for the treatment at 0.50 mg ozone per gram of tomatoes (Figure 3). This value (18.06 g/kg) differed significantly from values for the treatments of ozone 0.25 mg/g (17.67 g/kg), 1.00 mg/g (17.42 g/kg) and 0 mg/g (16.04 g/kg).

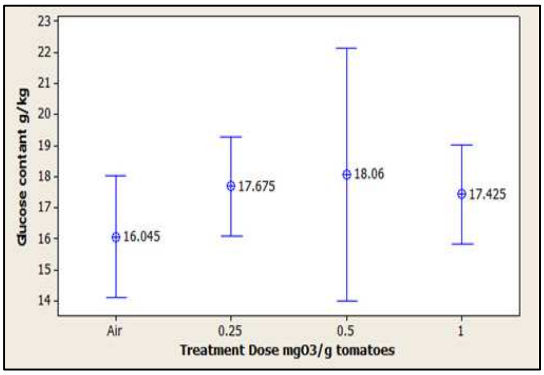

Fig. 3 Plot of glucose concentration (g/kg red tomatoes) vs ozone treatment doses

D. Effect of Different Ozone Doses on Fructose Content in Tomatoes at the Green stage of Ripeness

Fructose concentration in the tomatoes at the green stage increased with the use of ozone in the storage atmosphere. Values recorded were 11.0 4, 11.26, 11.73 and 11.64 g/kg of tomato under treatment doses of 0, 0.25, 0.50 and 1.00 mg/g respectively (Figure 4).

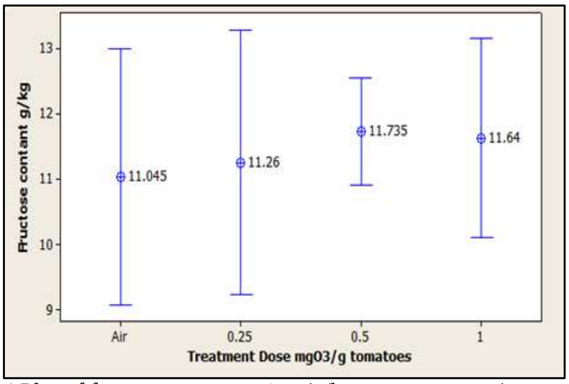

Fig. 4 Plot of fructose concentration (g/kg green tomatoes) vs ozone treatment doses

E. Effect of Different Ozone Doses on Fructose Content in Tomatoes in the Yellow Stage of Ripeness

Figure 5 shows significant increases in the contents of fructose in the yellow stage of ripeness with increasing ozone dose. The lowest content (15.38 g/kg) was in the control treatment (air) and the highest (16.95 g/kg) was observed when 0.50 mg of ozone per gram of tomatoes was used. On the other hand, doses of ozone of 0.25 and 1.00 mg/g were 16.20 and 16.38 mg/g respectively.

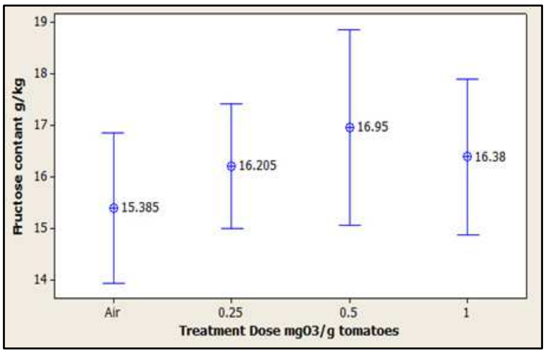

Fig. 5 Plot of fructose concentration (g/kg yellow tomatoes) vs ozone treatment doses

F. Effect of Different Ozone Doses on Fructose Content in Tomatoes in the Red Stage of Ripeness

Concentrations of fructose in tomatoes in the red stage of ripeness under the different treatments doses of ozone (Figure 6) follow similar patterns to those in the yellow and green stages. Mean value concentrations of fructose increased significantly from 16.61 g/kg in the tomatoes under control treatment (air) to 17.35 g/kg in tomatoes of the 0.25 mg/g ozone dose and to 18.14 g/kg in tomatoes under 0.50 mg/g ozone dose. A lower concentration (17.44 g/kg) was obtained for red tomatoes treatment with an ozone dose of 1.00 mg /g.

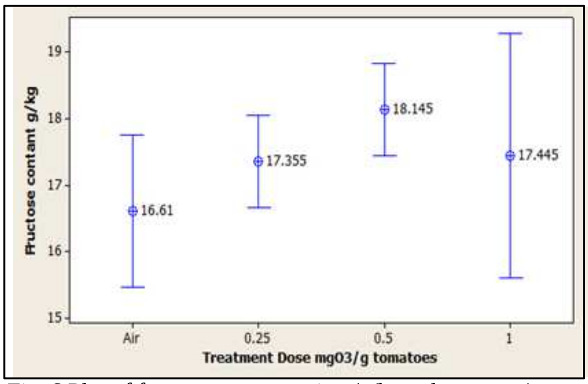

Fig. 6 Plot of fructose concentration (g/kg red tomatoes) vs ozone treatment doses

Results from previous studies indicated that storage of tomatoes in ozone enriched atmosphere resulted in increased levels of soluble sugars, especially glucose and fructose [9]. Preference for ozone treated tomatoes in which levels of glucose and fructose were following ozone treatment is consistent with the recognised influence of non-structural carbohydrate: organic acid balance on the taste (degree of sweetness and sourness) and flavour of tomatoes as perceived by senses [10]. These findings were consistent with the reported increase in glucose and fructose content reported in tomatoes [11] and strawberries [12] in response to low atmospheric ozone enrichment. Ozonated water treatment resulted in no significant difference in total sugar content of celery [13]. [8] stored strawberries for 3 days at 2°C in an atmosphere storage containing 0.35 ppm ozone, and they were transferred to 20°C and stored for 4 days. Sucrose contents of treated and non-treated fruits decreased with the storage. A fluctuation in glucose and fructose levels was from day 0 to day 5. The pattern of conversion of sucrose to glucose and fructose is significantly different in treated and non-treated fruits. A low content of sucrose, glucose and fructose was measured on the third day of storage. This might be due to an activation of sucrose degradation pathways in response to the oxidative stress caused by ozone [8].

IV. Calculations

The highest value of glucose in green and red tomatoes were in the fruits exposed to ozone in a dose of 0.50 mg/g (14.83 g/kg) and(18.06 g/kg) respectively, Concentrations of glucose in tomatoes at the yellow stage increased under exposure to ozone and with the increase in ozone dose. The highest value of fructose in green yellow and red tomatoes were in the fruits exposed to ozone in a dose of 0.50 mg/g (11.73 g/kg), (16.95 g/kg) and (18.14 g/kg) respectively. The concentrations of the glucose and fructose increased in the tomatoes which were subjected to ozone treatments. Results from this study show that controlled atmosphere storage of tomatoes using ozone is a viable technique which warrants further study.

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