Modifications of Bostwick method to determine tomato concentrate consistency

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Abstract
Evaluation the consistency of tomato concentrate with different °Brixes showed that the error in consistency measurement of tomato concentrate by Bostwick method aroused especially at high °Brixes. The studies indicated that the drying rate of insoluble solids and the lacking of reconstituting properties of them, caused error. In this research the effect of variety, concentration and the temperature of consistency measurement were evaluated to determine variation of error in Bostwick consistometer and to modify it. The results showed that variety had no effect on the accuracy of consistency measurement by Bostwick method, but concentration and temperature had a highly significant effect on the accuracy of this assay and thus the error of Bostwick consistometer increased, especially at high °Brixes. Also heating of diluted tomato concentrate (up to 45 °C) and then cooling it could decrease the error of consistency measurement considerably. Consistency can also be estimated accurately using the Correlation between °Brix , temperature and Bostwick consistency (R^2= 0.94).

Key words: Bostwick consistometer, Tomato concentrate, Tomato variety,

1. INTRODUCTION

The consistency of tomato concentrate and other products is affected by the simultaneous presence of whole cells, cell residues, pectic components and their surface, and serum soluble pectin. Marsh et al. (1980) found that the consistency depends mainly on the insoluble solids to total solids ratio [1]. Bostwick consistometer was recommended by Mohr for daily analysis of tomato products because of its simplicity and low cost [4]. Some researches noticed a consistency decreasing during re-hydration of tomato concentrates [2-5]. Marsh et al. (1980) applied Bostwick consistometer to show that concentrating of tomato juice especially in high °Brixes will increase the error measurement consistency. The current research was carried out to evaluate the changes of Bostwick consistency with the increase of °Brix and temperature for two tomato variety and to determine the Bostwick consistometr error more accurately and to modify it [2-5].

2. MATERIALS AND METHODS

About 1400kg of tomatoes were sampled from the research farm of Faculty Agricultural Ferdowsi University for each experimental replication. Tomatoes were treated at 85°C (hot-break) and then the concentration was carried out in vacuum vessel. During concentration, samples were taken at desired °Brixes. Treatments: (1) Tomato variety at two levels: Calj-N3 and Early Orbana-Y which are best for tomato concentrate production. (2)Tomato concentrate °Brix at five levels: 12, 16, 20, 24 and 28. (3)Temperature of consistency measurement at four levels: 25, 35, 45 and 25T (25T relates to the sample which is cooled to 25°C after heating up to 45°C).

Consistency: Tomato concentrates samples were diluted to 12 °Brix. Then their consistencies were measured by Bostwick consistometer at 25°C. The results were reported as the distance traveled (cm) in 30 seconds (Barrette, D.M., and et al.)

Brix: The brix of sample were read through a table refractometer at 20°C and in three replications.

Statistical Design: Factorial test with three factors was used on the basis of completely randomized design with eight replications to evaluate the effects of treatments on the changes of Bostwick consistency of tomato concentrate samples. The correlation and regression relationship between the effects of treatments was used to estimate Consistencies of tomato concentrates.

3. RESULTS AND DISCUSSION

As it was mentioned, the error, which occurs in the measurement of tomato concentrate consistency by bostwick method, is high, especially at high °Brixes.

Effect of concentration: The consistencies of both varieties were decreased significantly as the °Brix increased(figure 1). This decreasing, especially at Brixe, higher than 16, was very significant. This effect can be due to re-dilution effect of tomato concentrate at °Brixes higher than 12 for measuring consistency by Bostwick method. Re-dilution causes insoluble solids and especially pectin compounds not to hydrate well, and so increases the error in the measurement of tomato concentrate consistency. This error increases when the consistency and amount of added water for regulating °Brix increases Figure (1). Statistical analysis of the results showed that there were no significant effects between variety and °Brix on the consistency of tomato concentrates. Both varieties showed similar changed with the increasing of

°Brix, although the difference between consistencies was significant.

Effect of temperature: As it was shown in figure (2) when temperature raised from 25 to 45°C, a significant increasing occurred on the consistency of all samples measured by Bostwick method. But the 25T sample (The sample which is cooled to 25°C after heating at 45°C) showed a significant decreasing, compared with the other temperatures. This change confirms the high error in Bostwick measurement of tomato paste consistency, especially at high Brixes due to re-dilution and lack of re-hydration. This error can be decreased significantly by utilization of this heat treatment and by increasing of re-hydration ability of insoluble solids and pectin compounds. Statistical analysis of results showed that there was no significant effect between variety and measuring temperature on the consistency of tomato paste. Both varieties showed similar changes with temperature rise and heat treatment, although the difference in their consistency was significant. In the other words, the error in consistency measurement is not depended to variety, especially at high °Brixes and when the processing and measurement conditions are constant, this error is the same. Thus, the error in the measurement of tomato concentrate consistency by Bostwick method is decreased significantly by use of the recommended heat treatment (Heating the diluted tomato concentrate up to 45°C and then cooling to 25°C). Also, the results showed that the consistency measured by Bostwick method depends highly on the °Brix and the temperature of tomato concentrate (for both varieties). The results of statistical analysis of the obtained equation for the estimation of Bostwick consistency of tomato concentrate showed a very significant correlation coefficient (R^2=0.94). The regression equation was obtained from the changes of Bostwick consistency with the change of °Brix against temperature of tomato concentrate. Figure 3 shows the regression curve of the following equation for the estimation of consistency according to °Brix and temperature change. So, consistency of tomato concentrate at each temperature and °Brix can be easily estimated.

$$Y=2.98+ (0.013*T) + (0.08*B)$$

Bostwick consistency (cm)= Y
°Brix tomato concentrate= B
Temperature (°C) = T

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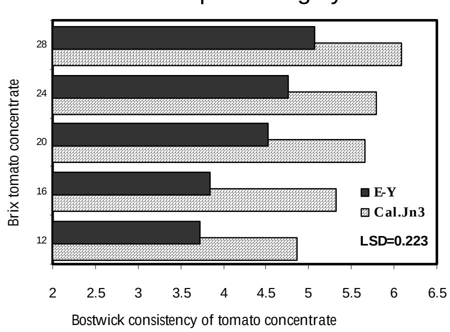

Figure 1: Effect of concentration on Bostwick consistency

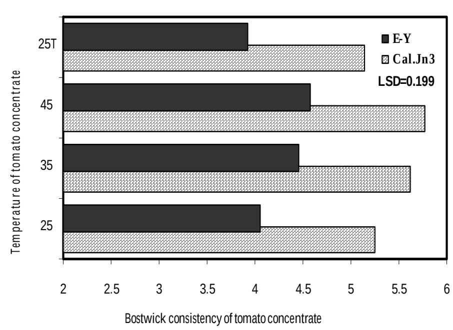

Figure 2: Effect of temperature on Bostwick consistency

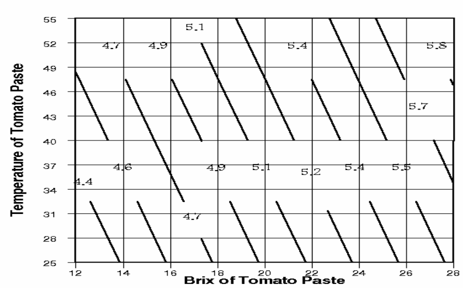

Figure 3: The regression diagram for the estimation of consistency from °Brix and temperature