Application of Time Temperature Indicator (TTI) using Maillard Reaction for Determination of Harvest Timing of Fruits and/or vegetables

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In this study, we investigated the color change in Maillard reaction by xylose (reducing sugar) and glycine (amino acid) for the consideration of using possibility as a determination index of harvest timing for high quality agricultural product. The concentrations of the reactants were as follows; D-xylose (1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 7.0 mol/L) and glycine (1.0, 1.5, 2.0, 2.5 mol/L). The color variation of the solutions under temperatures 20, 25 and 30°C was evaluated as digital data in R (red), G (green), and B (blue) by taking pictures using a digital camera. The color variation as expressed of changes in the a unification RGB value during reaction period was described as a sigmoid formula.

The clear color change from colorless, light yellow, light brown, brown, dark brown, to black was observed in the solution during the reaction. The RGB value was decreased sigmoidally in all conditions. The Maillard reaction rate was increased at higher temperatures and higher concentrations of reactants. The completion times (Red value < 0.1) of color variation was ranged from 29 - 420 days, 15 - 230 days and 10 - 120 days at 20, 25, and 30°C, respectively. The modeling of color variation expressed as unification RGB changes showed highly goodness-of-fit such as 0.04 in root mean squared error (RMSE). The TTI based on Maillard reaction can be realized with high flexibility of reaction time by controlling the concentration of the reactant. Since the optimum temperature for general fruits and/or vegetables growth is ranged from 15 to 30°C and the growth period is ranged from 10 to 70 days after flowering at generally vegetables, growth period was includes in the completion time of the Maillard reaction. Therefore, the TTI based on Maillard reaction will be highly applicable for determination of harvest timing of fruits and/or vegetables.