A study of color development from D-psicose and Methionine Maillard Reaction Products (MRPs)

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Abstract. The effect of heating time on the Maillard reaction between D-psicose and methionine to produce Maillard reaction products (MRPs) was investigated. This research was conducted at 50°C under aseptic condition. Color development was determined using chroma meter to obtain the value of L*, a* and b* every hour for 16 hours. The results showed that the elevation clearly appeared in the last heating process as the color changed of L* value was decreased. As conclusion, the heating process of D-psicose and Methionine provide development on color appearance against time of heating. This result may have benefit in food application as seasoning.

1. Introduction

The thermal reaction between reducing sugar and amino acid or peptide is known as Maillard reaction [1]. The conjugation between both compounds were formed from Amadori rearrangement by condensation of carbonyl-containing ε-amino groups [2]. This resulted dark-brown polymeric compounds and aromatic compounds intermediates are considered as Maillard reaction products (MRPs) which have gained attention as beneficial antioxidant in food systems [3]. MRPs play important roles as flavor-enhancing, off-flavor removal and health aspects [4]. Maillard reactions are based on several controlling factors such as the type of sugar and amino acids, temperature, pH, and heating time [4].

D-psicose (C3-position epimer of D-fructose) is a rare sugar that has a sweetness equivalent to 70% sucrose [3]. D-psicose has been widely studied because of its functional properties, which can prevent postprandial hyperglycemia and can be used as a sweetener that has high antioxidant activity and is low in calories [5]. While, methionine is an essential amino acid that cannot be produced by humans and is found in many foods such as fish, eggs, and vegetables [6]. This research is focused on the study of the color development of D-psicose and methionine from Maillard Reaction Products (MRPs).
2. Materials and methods

2.1. Maillard reaction
This study about Maillard reactions using D-Psicose for rare sugar was obtained from Kagawa, Rare Sugar Research Center, Japan; and methionine for amino acid was purchased from Cheil Jedang Indonesia, Co. Ltd. Carbonate buffer solution pH 9 was obtained from the reaction between NaHCO₃ mixed with Na₂CO₃. Phosphate buffer solution pH 7 was obtained from the reaction between Na₂HPO₄ mixed with NaH₂PO₄. Aquades was obtained from Central Laboratory for Research and Service Diponegoro University, Semarang, Indonesia. Beaker cups, measuring cups, micro tubes, and plastic knives were used as the additional tools. L*a*b* colorimeter was used to measure the lightness of the Maillard reaction production.

2.2. Buffer solution preparation
NaHCO₃ dissolved in 250 ml aquades. Na₂CO₃ dissolved in 100 ml aquades. Poured the Na₂CO₃ solution to NaHCO₃ solution until pH 9. The two solutions are mixed in a beaker then put in the carbonate bottle. This carbonate buffer solution pH 9 was used for dissolved D-psicose and lysine before being given a high temperature.

Na₂HPO₄ dissolved in 250 ml aquades. NaH₂PO₄ dissolved in 250 ml aquades. Poured the Na₂HPO₄ solution to NaH₂PO₄ solution until pH 7. The two solutions are mixed in a beaker then put in the phosphate bottle. This phosphate buffer solution pH 7 was used for dissolved D-psicose and lysine after being dried in high temperature.

2.3. Maillard reaction production preparation
Preparation of MRPs methods were adopted from other researchers [7]. D-Psicose (5g) and methionine (5g) were dissolved in 100 ml carbonate buffer pH 9. All 100 ml solution then transferred and divided into 20 ml to each petri dish.

2.4. Maillard reaction application
Maillard Reaction Application All samples were adopted from other researchers [8] heated at 50-55°C for 16 hours in a cabinet dryer. Dried samples were then cooled for stopping the Maillard process in the freezer (-4°C) for 1 minute. Samples diluted first before observed with 20 ml phosphate buffer pH 7 and made sure to mix it then used for analysis. Samples were observed every 4 hours until the 16nd hour.

2.5. Browning color test
The color development measurement adopted from other researches [9]. MRPs from D-psicose and Methionine Color development were determined using colorimeter (TES-135A; USA) to obtain values L* (lightness) a* (redness) b* (yellowness) then calculate the browning index. by observing the samples every 4 hours from the 0th hour until the 16nd hour.

2.6. Data analysis
The value of L* (lightness), a* (redness), and b* (yellowness) calculated using Microsoft Excel 2010 to find BI value. This study used a descriptive analysis.

3. Results and discussion
Sugars and proteins in most foods when given heat treatment together will involve in Maillard reactions that are related with the development of color. Maillard reactions from sugar D-psicose and amino acid methionine generate MRPs marked by different brown color. This different intensity of brown color due to carbonyl groups of sugars with amino acids occurred during heat treatment [10]. The result showed the longer the heating period, the darker the color will be (Figure 1).
Figure 1. MRPs Samples on a. 4th, b. 8th, c. 12th, and d. 16th hours of observation.

Browning color development is indicated as the process of Maillard reaction [11]. The colors of the samples were measured by colorimeters. Browning index values were shown in Figure 2. It showed that the reaction between amino acid methionine with D-psicose sugar increased along with heating time. The a*- (redness yellowness) during heating time was increased but the L* (lightness) was decreased. The last 16 hour is the culmination of browning color compared to the previous hour.

Figure 2. The value of L* in MRPs during 16th hours with heating treatment in 50-55°C.

4. Conclusions
From this research it can be concluded that browning color will develop along with heating time. This may be caused by rearrangement of Amadori which produced intermediates compounds. These compounds are beneficial as off-flavor removal in food system.

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