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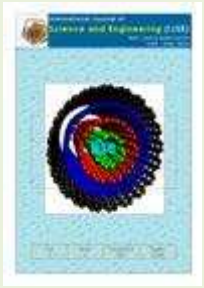

Changes on the Physical-Chemical Properties of Kue Delapan Jam on Various Steaming Time

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Abstract *- This research intended to study browning reaction between glucose, fructose, and lipids with amino acids in real system during making Kue Delapan Jam. Research applied completely randomized design with steaming time as treatment (2, 4, 6, and 8 hours) with 3 replication. The development of color and browning index were ivestigated by using lightness, redness, yellowness, and total color difference (TCD) during reaction, and the absorbance of methanol extracts was measured at 420 nm in 40.0 mm silica. The development of texture was monitored by using Bookfield texture analyzer. Test results showed that steaming time influenced the color, browning index, texture, protein, and fat content of the cake significantly. Steaming time has no effect on water content. There were positive correlation between steaming time with TDC, redness, texture, and browning index during course. While for lightness, yellowness, pH, protein, and fat content indicated negative correlation. Changes on texture, TDC, browning index, protein, and fat content followed linear model.*

Keywords— *Kue delapan jam; physics- chemical properties; steaming time.*

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I. INTRODUCTION

The Kue delapan jam is a traditional cake of Palembang area. It is made from eggs, sugar, sweetened condensed milk and margarine which steamed for 8 hours. Physically KDJ is brown in color, soft textured with a fairly high water content of> 40%.

In making KDJ, browning and texture are important determinant of quality. KDJ which is less brown considered not quite meet the quality requirements. Similarly for the texture, KDJ which look like soft and less dense deemed not meet quality requirements. Browning and texture are major problem in the processing KDJ. The formation of brown pigment and dense texture are very slow so it takes as long as 8 hours to get good quality of cake.

The brown color of KDJ comes from the browning reaction that occurs during steaming. Browning reaction occurs via the *Maillard* reaction and lipid oxidation. *Maillard* reaction occurs between the carbonyl compounds (fructose and glucose) with amino acids, protein, and peptide (Saltmarch and Labuza, 1982; Ames, 1990; Nursten, 2005; Yu and Zhang, 2010; Bastos *et al*., 2012). *Maillard* reaction causes the formation of H^+ ions, thus lowering the pH of the system. The decline in pH causes the rate of *Maillard* reaction decreases (Saltmarch and Labuza, 1982; Nursten, 2005). Additionally decreasing in pH also caused by the formation of short-chain carboxylic acids such as acetic acid and formic acid (Martins and van Boekel, 2001; Nursten 2005; Rufian-Hanares, 2006). Steaming process caused a decline in the pH of the system that affects the formation of brown color. The decrease in pH leads to delayed formation of brown color on KDJ so it takes a long time to get the desired level of browning.

Browning also occured in the processing of foods containing lipids as a result of lipid oxidation. The products of lipid oxidation then react with amines, amino acids and proteins (Hidalgo and Zamora, 2000; Zamora and Hidalgo, 2005). Oxidation of lipids in food can occur in non-enzymatic reaction that known as auto-oxidation reaction. Auto oxidation occurs through a free radical mechanism and hydro peroxide. Hydro peroxides and free radicals are very reactive so they forms a complex reaction such as degradation and

interactions to produce brown oxypolimer (Hidalgo and Zamora, 2000; Zamora and Hidalgo, 2005).

Browning can be used indirectly in predicting the compounds present in a material, because it is easy and can be done quickly. Tristimulus color measurement has been used effectively in calculating the reaction rate of constants and activation energies on non-enzymatic discoloration (Ibarz, 2000; Lau, *et al*, 2000; Tosun, 2004; Mohammadi, *et al*, 2008; Tan, 2012).

Research on the kinetics of color changes on real systems have been carried out widely (Mohammadi, *et al*, 2008; Bosch, *et al*, 2007; Hutapea *et al*, 2004; Tosun, 2004; Lau, *et al*, 2000) . Most of studies revealed that color changes in the *Maillard* reaction followed zero-order kinetics (Ibarz, *et al*, 2000; Tosun, 2004; Mohammadi, *et al*, 2008; Jaiswal and Abu-Ghannam, 2013). However, those studies are limited to the process of bread making, milk processing and drying vegetable and fruits. Research on the changing of the chemical physical of complex systems have not been widely applied.

This research aims to study the changes on the physical-chemical properties of KDJ includes changes in color, moisture, protein, fat content, and texture formation in various steaming times of KDJ. The study also expected can be applied to predict the physical-chemical properties changes in the processing of other foods that contain carbohydrates, proteins and fats.

II. Material and Method

Materials used in this research were:

1) Raw material for KDJ making consist of hens egg, sucrose, margarine and sweetened condensed milk.
2) Research instrument such as weight scale of *Electronic Kitchen Scale* Model EK3651 with 2,000, hand mixer, baking pan, *autoclave*, *Hirayama type Hiclave- HVE-50*, Konica color reader, desiccators, glassware, incubator, magnetic stirrer, analytical balance, oven, Bookfield Texture Analyzer, Spectrophotometer (Hach).
3) The KDJ was made by mixing 1,500 g of eggs, 600 g sugar, 398 g sweetened condensed milk and 100 g margarine by using a hand mixer to obtain a homogeneous mixture. The mixture is then poured into the 20x20x7 cm baking pan that has been smeared with margarine. Then it was covered with aluminum foil to prevent water dropplet on the surface. Steaming process is then performed according to treatment time (2 h, 4 h, 6 h and 8 h). The cake was taken out and air cooled soon after steaming time reached to stop further reaction.

Research apply completely randomized design with 3 replication. The treatment was steaming time consist of 2 h, 4 h, 6 h, and 8 h. Data were analyzed by Duncan's multiple range tests using statistical package Statistica V 5.5 software. A significant level was defined as $P<0.05$.

Color was evaluated by using Konica Minolta *color Reader* measuring L (100 =White, 0=Black), a (+, red; -, green), b (+, yellow; -, blue). A white tile (No: 21733001) was used to standardize the instrument. Total Color Difference (TDC) calculated according to equation:

$$TDC = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2} \quad (1)$$

The value of L_0, a_0, and b_0 were measured after the mixture steamed for five minutes, so that the mixture becomes a solid and had flat surface .

Change on texture were measured by using Bookfield texture analyzer with a probe plastic cylinder diameter of 25.4 mm, trigger 100 g, speed of 1.0 m/sec with 10 mm distance. The moisture contents were measured by the difference of the sample weight after drying at 105 °C for 20 h. Fat contents were determined using the standard method of the Association of Official Analytical Chemists (AOAC, 1990). The protein content was determined by the semi-micro Kjeldahl method (ISO 5983-1-2005).

III. Result and Discussion

Moisture Content

The moisture content of KDJ ranged from 47.6 to 48.9%. This means that statistically the moisture content is relatively the same for all treatment. High levels of moisture showed that steaming process not able to evaporate the water content of the raw materials (dough), during steaming. The longer steaming time does not affect on the moisture content.

Texture

Test results for the texture showed an increased in texture during steaming. The texture changes during steaming followed a linear pattern. The longer steaming the more compact texture. Steaming time have a very strong correlation ($R^2 = 0.973$) with the rate of increase in texture. This is in accordance with Labuza *et al* (2008) who also found a linear pattern on change in the texture of whey-based foods during storage.

Texture is one of the most important quality attribute for foods. Change on texture could indicate deterioration in foods. Moisture, composition, pH and dimension are among factor those influence the texture.

Texture of KDJ were developped during steaming. Texture of KDJ which were steamed for 2 hours relatively softer than that of other treatments. This is due to the accumulation of high molecular weight compounds that are formed as a result of the *Maillard* reaction is not quite enough, so that the texture is quite soft. More over during steaming proteins interacts each other to form protein agglomeration and the *Maillard* reaction which affects the color and texture (Labuza, *et al*, 2008). Analysis of variance on the texture showed that steaming time have significant effect on the texture of KDJ.

Color

Color is important attribute for foods, caused it can be observed directly. More over color change or color formation can be used to predict reaction stages in food products such *Maillard* reaction stages (Francis, 1995 in Bastos, *et al*, 2012).

Brown color on KDJ generated from non enzymatic browning reactions namely *Maillard* reaction and lipid oxidation during steaming process. Reactants for *Maillard* reaction derived from sugar (sucrose) and lipids as a source of carbonyl compounds and proteins from eggs and milk as a source of amino acids. The source of lipids for the lipid oxidation derived from egg yolks and margarine.

Test results showed decline in the level of lightness (L) during steaming. Decreasing on the lightness caused by

browning reaction that occurs during steaming. The longer steaming, the darker color produced. The decrease in lightness during steaming indicates the accumulation of browning pigments which were formed during steaming process more and more. This is consistent with other studies that reported a decrease in the value of the lightness during processing and storage of foods (Ramirez-Jimenez, *et al*, 2000; Tosun, 2004; Coghe *et al*, 2006; Bosch *et al*, 2007; Mohammadi, *et al*, 2008; Matsuo, *et al*, 2012; Tan *et al*, 2012).

Analysis of variance showed that steaming time have significant effect on the lightness of KDJ. This result indicated that the rate of browning increase with increasing steaming time.

In contrast to lightness, the redness (+a) of KDJ was increasing consistently. The longer steaming, the higher redness. This is an accordance with other studies that also reported an increasing of redness during processing and storage of food (Tosun, 2004; Bosch *et al*, 2007; Mohammadi, *et al*, 2008; Capuano *et al*, 2008; Matsuo, *et al*, 2012; Zaman and Yang, 2013). Steaming time have a very strong correlation (linear regression $R^2 = 0.92$) with the rate of increasing of redness.

Analysis of variance showed that steaming time has significant effect on the redness of KDJ. Duncan test showed there were significant difference on the redness of KDJ which were steamed for 8 hours with those were steamed for 6 hours, 4, hours and 2 hours.

As for yellowness, steaming time resulted decrease in yellowness (b). This is in accordance with other studies which reported decreasing in yellowness during processing and storage of foods (Ibarz, *et al*, 2000; Tosun, 2004; Mohammadi, 2007).

Analysis of variance showed that steaming time have significant effect on the yellowness of KDJ. There were significant difference on the yellowness of KDJ which were steamed 8 hours with those were steamed for 2 hours and 4 hours.

The changes on the color of the cake during steaming were calculated as Total color difference (TDC). There were linear increasing of TDC during steaming. In the early stages there were significant increase in TDC. This indicated positive correlation between steaming time with rate of increase of TDC. The longer steaming, the higher change in TDC.

Browning Index

Browning on KDJ considered to be desirable caused it enhances the appearance and flavour in terms of tradition and consumer acceptance. Rate of browning reactions depends on temperature, pH, moisture content, time of heat treatment, the concentration and nature of the reactants (Saltmarch and Labuza, 1982).

Test result showed the increased in browning index during course. The longer steaming time, the higher browning index. Steaming time have significan effect on the browning index. This indicated the occurrence of the *Maillard* reaction and melanoidin formation during steaming. This result in accordance with numerous studies that showed the *Maillard* reaction is influenced by the type of reactants and duration of heating (Ames, 1998; Bosch, *et al*, 2007; Zaman and Yang, 2013).

Analysis of variance showed that steaming time influenced the browning index significantly. There were significant difference on the browning index which was steamed for 8 hours with those steamed for 6 hours. There were strong correlation between steaming time and rate of browning. Rate of browning increased with increasing steaming time. The difference on the browning index is due to melanoidin formation during steaming. The 2 hours steaming only produced brown pigment slightly. In the contrary steaming for 6 hours, and 8 hours, the brown pigment produced have accumulated quite a lot so it gave significant difference in browning index.

Fat Content

Test result on fat content showed a decreased during steaming. This was becaused the fat undergo auto-oxidation due to heat treatment to becomes hydroperoxide.The next step is degradation of hydroperoxides to become aldehydes and hydro carbon. Finally hydro peroxide and aldehyde polymerize into stable products and brown products (Hidalgo and Zamora, 2000, Fennema, 1996). In addition during steaming *Maillard* reaction also took place. *Maillard* reaction between lipid oxidation products with amines, amino acids and proteins cause browning in food processing (Hidalgo and Zamora, 2000). All reaction series during steaming caused decreasing fat content on the cake.

Analysis of variance showed that steaming time influenced the fat content significantly. Duncan least square test showed there were significant difference on the fat content of KDJ which was steamed for 8 hours with those steamed for 2 , 4 hours and 6 hours. There were no significant difference on fat content of KDJ which were steamed for 4 hours and 6 hours.

Protein Content

Test result on the protein content showed a decreased during steaming. This is becaused during steaming proteins undergo *Maillard* reaction with carbonyl compound which were derived from lipid oxidation to produce volatile aroma compound such as ammonia, carbon dioxide and strecker aldehyde. This in accordance with Van Ba, et al (2012) which states that amino acids can undergo the Strecker degradation that subsequently produce some reactive radicals such as ammonia, hydrosulfide and etc which also are able to further react with the secondary oxidized products of lipid to produce volatile aroma such as thiols, thiophenes, thiazoles and etc.

Analysis of variance showed that steaming time influenced the protein content significantly. Duncan least square test showed there were significant difference on the protein content which was steamed for 8 hours with that was steamed for 2 hours and the dough (H_0). No significant difference on the protein content of KDJ which were steamed for 8 hours, 6 hours, and 4 hours.

IV. CONLUSIONS

The above result showed that the steaming time influence on the physical-chemical properties of KDJ such as texture, color, browning index, protein and fat content. Steaming time have no effect on water content.

During steaming there were increased in texture, browning index, redness (a), and TDC. While for the lightness

(L), yellowness (b), protein, and fat showed a decreased. Changes in texture, TDC, redness, browning index, protein and fat content followed the linear models. The color, protein and fat content of KDJ which were steamed for 6 hours not significantly difference with were steamed for 8 hours. While as for texture, browning index and total color difference which were steamed for 6 hours significantly differ with were steamed for 8 hours.

Table 1. Physical-chemical properties of KDJ

Code	Texture	L	a	b	IB	TDC	Protein (%)	Fat (%)
H_0	-	77.70 a	1.40 a	24.23 a	-	-	10.99 a	14.77 a
H_2	1087.5 a	64.13 b	2.23 a	21.43 b	0.32 a	16.93 a	10.42 b	12.76 b
H_4	1232.1 a	56.03 c	7.40 b	15.57 c	0.39 a	27.27 b	9.88 c	9.71 c
H_6	1451.7 b	52.67d	9.73 bc	14.0 cd	0.44 ab	31.66 c	9.52 c	7.40 c
H_8	1762.8 c	50.9 d	10.3 c	12.67 d	0.65 c	33.94 d	9.06 c	5.50 d

*Data represent mean values (n = 3) of the measurements
Means marked with the same letter in each batch are not significantly different (P>0.05)

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