

Anti-Browning Effects on Baked Dough Made Using Silky Fowl Egg

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Abstract

The anti-browning effects on the Maillard reaction through calcination bread with silky fowl egg are discussed in the paper. Advanced glycation end product (AGEs) generation ratio in the case of 60 minute of baking dough with silky fowl egg has been suppressed and advantage compared to hen's egg. This behavior suggests that silky fowl egg suppresses Maillard reaction in the calcination of dough. As a result of measuring a cross-sectional view of the bread cavity holes fired, silky fowl egg showed an increasing trend compared to hen's egg. A positive correlation was observed between the cavity hole and AGEs yield. We used egg white and yolk in order to examine the difference in impact and properties of the egg as a Maillard reaction. AGEs produced by Maillard reaction, which proceeds during firing has been degraded by the egg yolk of silky fowl egg and hen's egg. On the other hand, degradation of AGEs was promoted by egg white, egg yolk of silky fowl egg has been presumed to inhibit the formation of AGEs amount as a result of reaction by inhibiting the Maillard reaction.

Keywords: *Silky fowl egg, Egg yolk, Anti-browning, Millard reaction, AGEs*

1. Introduction

Silky fowl eggs are well known in the Orient and for thousands of years have been credited with medicinal and health-promoting values. However, a modern scientific approach has only recently been applied to determine their medicinal, chemical, and biochemical components (Sakakibara et al., 2000; Ferrand et al., 1985). Recently, we reported that silky fowl eggs are a chemical storehouse and an excellent source of sialic acid (Koketsu et al., 2003), which is an important component for the protection of life (Koketsu et al., 1995; Koketsu et al., 1997), and that silky fowl eggs are an excellent food material (Carefoot, 1993; Koketsu et al., 2004; Toyosaki et al., 2004). We also recently found that silky fowl egg inhibit the Maillard reaction, which occurs during the baking of dough. The Maillard reaction is a dynamic reaction that occurs during the bread-making process, and is thought to significantly

affect the appearance of the baked dough, as well as its flavor and texture. It plays a significant role in the formation of brown color on the surface of bread during baking, and we found that different shades of brown are produced by the Maillard reaction depending on the presence of added eggs. The object of the current study was to investigate the anti-browning effects of the calcination dough with silky fowl eggs compared with calcination dough with hen's eggs of white leghorn origin.

2. Materials and Methods

2.1 Materials

Materials were purchased from the following sources. Spring wheat flour (Super King; 13.8% protein, 0.42% ash, 14% water) was obtained from Nisshin Flour Milling Inc. (Chiyoda, Tokyo,

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Japan). The contents of protein, ash, lipid and water were 13.1% (Kjeldahl, N x 6.25), 0.4%, 1.8% and 15.0 %, respectively. More than 95% of the flour granules were sifted through the sieve of 132- μ m mesh. Dried yeast (*Saccharomyces cerevisias*) was purchased from S.I. Lesaffre (Marcq-en-Baroeul, France). Gluten (more than 90% pure), glucose and lysine were purchased from Nakarai Tesque, Inc. (Kyoto, Japan). Other reagents were of special grade and were obtained from Nacalai Tesque.

Eggs of silky fowl and White Leghorn hens were a kind gift from Kyanari 21 Co., Ltd., Gifu, Japan. Each fresh egg fraction was obtained from eggs collected within a day after laying and immediately used for these experiments. Eggs were collected from flocks of 20 silky fowls and 20 hens; ten sponge cakes were made; two eggs were included in each cake. Exactly the same feed was given to the silky fowls and hens received and they were also kept under the same breeding conditions.

2.2 Preparation and Baking of Dough

Bread dough was prepared using commercially available ingredients for preparing bread dough and by employing the straight dough method. More specifically, dough was prepared using ingredients for preparing a loaf of bread, that is, lipid, strong flour, live yeast, water, sugar, salt and skimmed milk powder. After mixing, whole egg was added to the mixture. Five dough per type of bird (silky fowl or hen) were prepared, each dough was made from 2 eggs, and these 2 eggs had been laid by different birds as eggs were used within 1 day of laying in order to assess the statistical significance of silky fowl vs. hen. Five replicates of each type of dough (whole silky fowl egg and hen's egg, and egg yolk and egg white) were prepared.

Dough temperature at the completion of mixing was 26°C, and the dough was fermented for 90 minutes at a temperature of 28 to 30°C. The dough was then molded, and the molded pieces were subjected to final fermentation for 60 to 70 minutes at a temperature of 36°C and a humidity of 75%, followed by baking for 35 to 40 minutes at temperatures of 230°C (top of oven) to 210°C (bottom of oven). Dough subjected to only primary fermentation was also used in this experiment.

2.3 Extraction of Advanced Glycation End products (AGEs), the Maillard Reaction Products, from Faked Bread

AGEs were extracted from 100 g of baked bread using 50 ml of 0.25 M phosphate buffer (pH 7.4).

2.4 Determination of Amounts of AGEs

AGEs are brown pigments, and its absorbance at 420 nm (brown color development) was thus measured. The amounts of AGEs in each bread were determined by measuring the absorbance at 420 nm using a spectrophotometer (U-2000, HITACHI Co., Ltd., Tokyo, Japan).

2.5 Preparation of AGEs

AGEs were prepared in the following manner: 0.5 mm glucose and 0.5 mm lysine were dissolved in 30 ml of distilled water, followed by heating it in a water bath for 50 minutes. The resultant mixture was used as AGEs in the experiment.

2.6 Preparation of Mixtures of AGEs, Gluten and Egg Yolk and Egg White of Silky Fowl and Hen's Eggs

In order to investigate the mechanisms of action of Silky fowl egg on AGEs, we prepared dough using egg yolk or egg white; it was prepared with the same mixing ratio as used for preparing a loaf of bread. After addition of 20 ml of AGEs prepared in advance, the mixture was mixed for 20 minutes before being used in the experiment.

2.7 Structural Analysis Using Image J

Cut sections of baked bread were prepared, and images obtained using an optical microscope loaded onto a PC. Using the "analyze particles" function of Image J (Ver. 1.45, free software), changes in pore distribution were measured and analyzed.

2.8 Statistical Analysis

All data were presented as mean $\pm$ standard deviation. Statistical comparison between different treatments was done by *t*-test, which was authorized using Duncan's new multiple range test (Steel et al., 1980) and application software Stat View 512 only for statistics + (Brain Power, Berkeley, CA, USA). Significance level is $p < 0.05$ unless otherwise indicate.

3. Results and Discussion

3.1 Changes in Amount of AGEs Produced During Baking

Figure 1 shows the changes in the amount of AGEs produced by the Maillard reaction during baking. When silky fowl's and hen's, which are whole eggs, were used, the amount of AGEs tended to be smaller than when only hen's eggs were used.

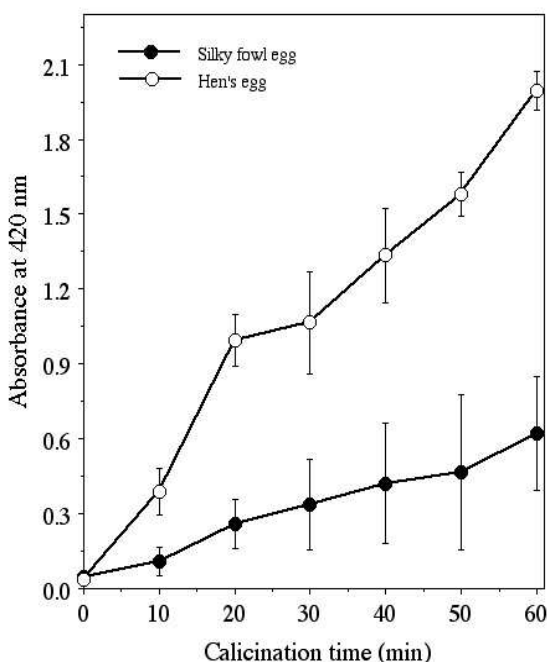


Figure 1: Changes in amount of AGEs produced by the Maillard reaction during baking

In particular, when merely silky fowl eggs were used, the amount of AGEs was found to be significantly smaller. These results show that silky fowl egg inhibits the Maillard reaction that occurs during baking when compared with hen's eggs. Chi-Hao et al., (2011) introduced major AGEs in his recent report on AGEs. In the present study, the structures of the AGEs produced during baking were not determined; and in what manner the different properties of the added eggs are involved in the Maillard reaction is unknown. Further study is thus needed. Browning index is considered to reflect the final products of a process known as nonenzymatic browning or the Maillard reaction (Aoki et al., 1999; Manzocco et al., 2001; Rosario et al., 2000; Catillo et al., 1998; Anese et al., 1999). The browning index measures the brown

pigment formed during the Maillard reaction in thermally processed foods such as baked bread, in which Amadori compound formation contributes to color development.

3.2 Changes in Pore Distribution Analyzed Using Image J

After taking pictures of cut sections of the baked bread, changes in pore distribution were studied using Image J (Figure 2). After using silky fowl egg the pore distribution showed a tendency to increase as compared to when hen's eggs were used. Pore distribution significantly affects food texture. These results suggest that using silky fowl egg results in a less desirable texture than using hen's egg. In order to confirm this, sensory evaluation was performed, and a lower overall evaluation was obtained when silky fowl egg was used instead of hen's egg. In addition, a functional test was conducted to target 50 female students out of the twenty-year-olds trained.

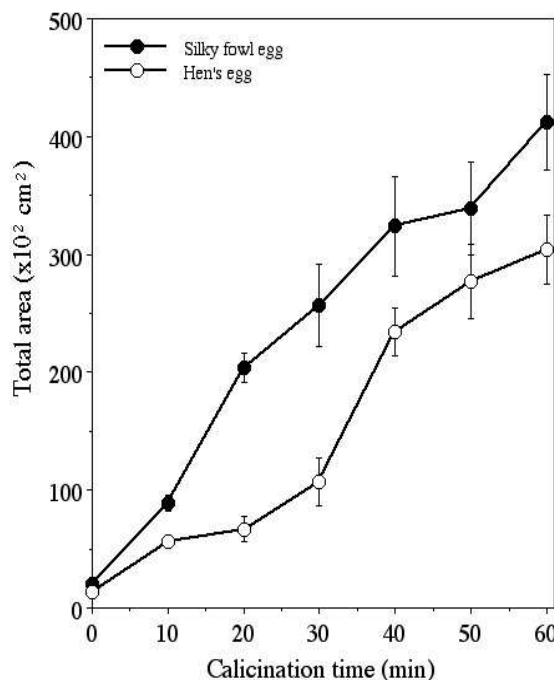


Figure 2: Changes in pore distribution in baked bread

3.3 The Relationship between the Amount of AGEs and the Total Area of Cut Section of the Baked Bread

It is shown in Figure 3, that the results examined the relationship between the total area of cut

section of baking bread and browning products (AGEs) in a Maillard reaction. A positive correlation was observed in the total area of baking bread and the amount of AGEs. From this result, AGEs generated are considered likely to be involved as one of the factors that influence the taste of the bread.

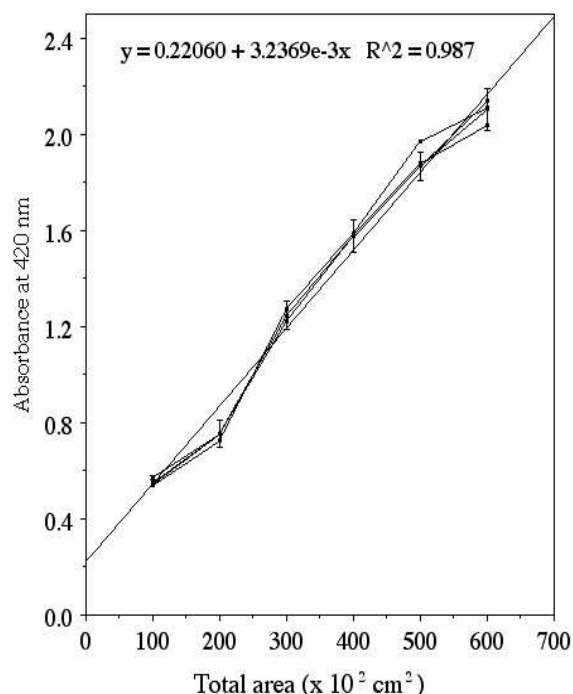


Figure 3: The relationship between the total area of cut section of baked bread and the amount of AGEs

3.4 Changes in Amount of AGEs Produced During Baking with Egg Yolk, and Egg White

The amount of AGEs produced by the Maillard reaction during baking was found to differ significantly depending on whether silky fowl or hen's egg was used. When silky fowl eggs were used, the amount of AGEs produced by the Maillard reaction was found to decrease. This suggests that silky fowl egg themselves inhibit the Maillard reaction (Figure 1). To clarify how silky fowl eggs are involved in the Maillard reaction, an egg yolk and egg white mixture of silky fowl egg was prepared to be compared egg yolk and egg white of hen's egg. In this experiment the components that induce such phenomena were investigated. Egg white and yolk fractions were

investigated in accordance with the experiment of Figure 1.

Figure 4 shows the variation in the amount of AGEs produced by the Maillard reaction during firing. When using egg whites and egg yolks of silky fowl's and hen's eggs, in both cases this mixture tended to have larger amount of AGEs then when only egg yolks were used. From this result it was evident that egg yolk was found to have significantly smaller amount of AGEs. Egg yolk has been shown to inhibit the Maillard reaction that occurs during firing.

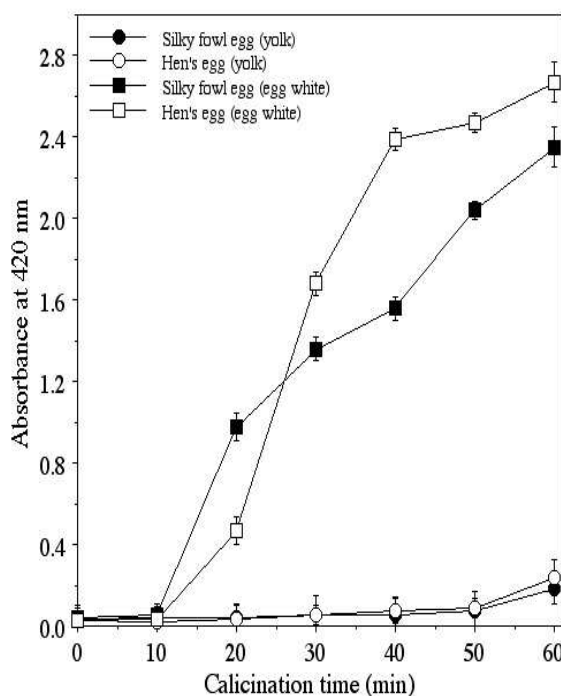


Figure 4: Changes in amount of AGEs in the egg yolk and egg white of silky fowl egg and hen's egg.

3.5 Changes in Pore Distribution in Baked Bread with Egg Yolk, and Egg White analyzed by Image J

After obtaining images of cut sections of bread prepared using egg yolk and egg white, changes in the pore distribution were studied using Image J. The results are shown in Figure 5. Due to the absence of various additional auxiliary ingredients in the model system, the number of pores tended to increase. When egg yolk of silky fowl egg and hen's egg were added, the number of pores was often found to be significantly smaller ($p < 0.05$)

than egg white of silky fowl egg and hen's egg. The quality of the pore distribution depends significantly on the conditions during fermentation, but this study suggests that the quality of pore distribution is also significantly affected by the Maillard reaction that occurs during baking.

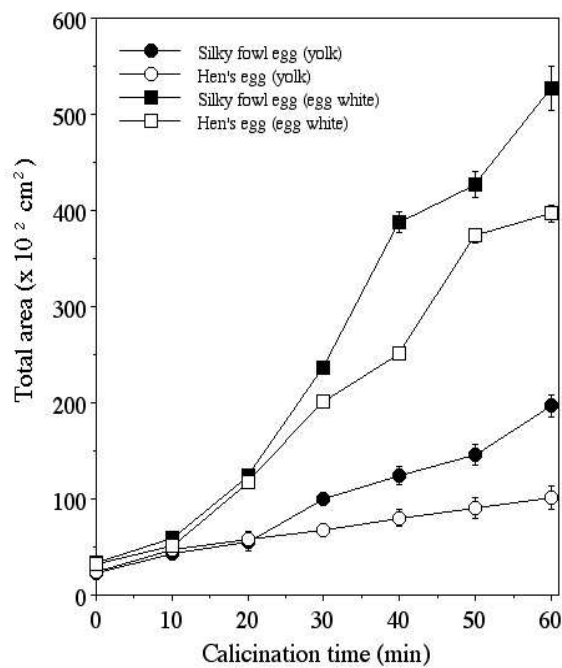


Figure 5: Changes in pore distribution in baked bread with egg yolk and egg white of silky fowl egg and hen's egg.

3.6 Percentage of Added AGEs Decomposed During Baking

We investigated the degree of decomposition of added AGEs during baking. The results are shown in Figure 6. When egg yolk and egg white of silky fowl egg or hen's eggs were used, the percentage of decomposed AGEs was significantly higher ($p < 0.05$) than egg white of silky fowl egg and hen's egg. In contrast, when egg yolk of silky fowl egg and hen's egg was used, the percentage of decomposed AGEs was found to be lower.

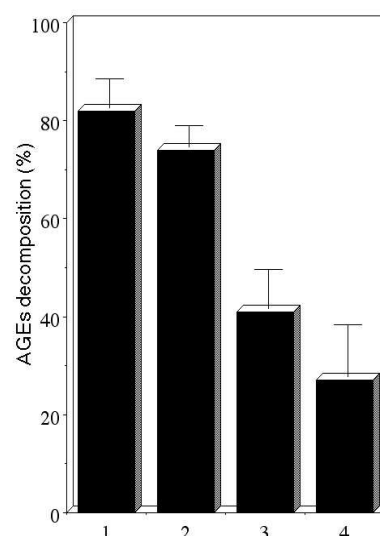


Figure 6: Percentage of added AGEs decomposed during baking. 1: Egg yolk of silky fowl egg; 2: Egg white of silky fowl egg; 3: Egg yolk of hen's egg; 4: Egg white of hen's egg

4. Conclusion

This study showed that silky fowl egg at least inhibits AGEs production in the Maillard reaction that occurs during baking. In the case of silky fowl egg (in particular, egg yolk), constituent egg yolk was found to play a significant role in the Maillard reaction, and therefore the relationship with fatty acids needs to be studied in detail in the future.

AGEs are produced by the Maillard reaction that occurs during the bread baking process. This study revealed that adding silky fowl egg inhibits the amount of AGEs produced, and it is believed that this finding is novel. We also found that this is caused by the fact that silky fowl egg, with the constituent egg yolk, are strongly involved in the Maillard reaction, resulting in inhibition of the Maillard reaction. Furthermore, pore distribution, after baking, was found to be strongly related to AGEs.

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