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Research Article

Rheological Properties and Oxidative Stability of Baked Sponge Cake Using Silky Fowl Egg

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Abstract: Baked sponge cakes using silky fowl egg and those using hen eggs were prepared, respectively. The rheological properties, lipid peroxidation and water content of the baked sponge cakes using silky fowl egg compared with those of the cakes using hen egg. The height of the baked sponge cake using silky fowl egg became higher than that of the sponge cake using hen egg. The baked sponge cake using silky fowl egg showed hardly change in hardness and adhesion of the cake for 10 days at room temperature. In contrast, the cake using hen egg increased drastically a hardness of the cake and decreased an adhesion of the cake. Though water content of the sponge cake using silky fowl egg showed hardly change on 10 days of storage at room temperature, the cake using hen egg significantly decreased water content of the cake. The sponge cake using silky fowl egg showed restricted generation of hydroperoxides for 10 days in storage at room temperature. In contrast, the cake using hen egg showed an increased amount of hydroperoxides for 10 days. The present experiments suggested that the use of silky fowl egg could improve a quality and oxidative stability of baked cakes.

Keywords: Baked sponge cake, hen's egg, oxidative stability, rheological properties, silky fowl egg

INTRODUCTION

The eggs of the original silky fowl are well known in the Orient and for thousands of years have been credited with famous medicinal and health-promoting values. However, a modern scientific approach has only recently been applied to determine its medicinal, chemical and biochemical components (Sakakibara *et al*., 2000; Ferrand and L' Hermite, 1985). Recently, silky fowl's eggs are considered to be a chemical storehouse and an excellent source of sialic acid (Koketsu *et al*., 2003), which is an important biological properties (Koketsu *et al*., 1995, 1997) and that silky fowl eggs are considered to be an excellent food material (Koketsu and Toyosaki, 2004; Toyosaki and Koketsu, 2004).

The object of the current study was to investigate rheologic properties and oxidative stability of baked sponge cake using silky fowl egg compared with the cake using hen eggs of white leghorn origin.

MATERIALS AND METHODS

Materials: Flour was purchased from Nippon Suisan (Tokyo, Japan). The contents of protein, ash, lipid and water were 13.1% (Kjeldahl, N×6.25), 0.4, 1.8 and 15.0%, respectively. More than 95% of the flour granules were sifted though the sieve of 132-mm mesh.

Eggs of silky fowl and hen, White Leghorn origin were a kind gift from Canaly 21 (Co., Ltd., Gifu, Japan). Each fresh egg fraction was obtained from the eggs collected within a day after lying and immediately used for these experiments. Eggs were collected from flocks of 20 silky fowls and 20 hens. A total of 10 sponge cakes were made, two eggs being included in each cake. The same feed was given to the silky fowls and Leghorns and they were kept under the same environmental conditions.

Recipe for sponge cake: The formula of each sponge cake was as follows: 300 g flour, 6 g sodium chloride, 20 g sucrose, 5 g linoleic acid (Sigma-Aldrich, St. Louis, MO.), 40 g whole egg and 60 g water. The mixture, except egg, was stirred at 25°C at 50 rpm for 20 min. After mixing, whole egg was added. After further mixing, the dough was placed in 30 cm frame and baked for 30 min at 210°C. For each type of bird, 5 replicate cakes were prepared. Each sponge cake was made from two eggs, which had been laid different birds.

Measurement of water content in the sponge cake: Water contents of each baked sponge cake using whole silky fowl and using hen egg was, respectively, determined according to AACC methods 44-15A and 44-40 (AACC (American Association of Cereal Chemists), 1995).

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Determination of rheological properties: Hardness and adhesion of each baked sponge cake using whole fowl and using hen egg was measured by rheometer (TPU-2S, YAMADEN Co., Ltd., Japan). A sponge cake set into a rheometer cell of 42 mm across and 16 mm high. The cylinder type plunger of a diameter of 15 mm compressed into the cake in the cell at 5 mm intervals and at a compression rate of 1 mm a sec. Quarterly trials were carried out within 5 min of each other. Each value represents the mean ± standard deviation.

Measurement of hydroperoxide in the sponge cake: Oxidative stability of each baked sponge cake using whole silky fowl and using hen egg was evaluated by ferric thiocyanate (Chen *et al*., 1996) for 10 days on storage at room temperature. The ferric thiocyanate analysis method was performed as follows. The baked sponge cake was extracted with chloroform and methanol; 2/1, v/v. To the solvent extract (50 µL), 75% ethanol (2.35 mL), 30% ammonium thiocyanate (50 µL), and 20 mM ferrous chloride solution in 3.5% HCl (50 µL) was added. After 3 min, the absorbance of the solution was measured at 500 nm in a 1 cm cuvette with a UV spectrophotometer (U-2000, HITACHI Co. Ltd., Tokyo, Japan).

Statistical analysis: All data are means the mean ± standard deviations. For the each experiment of water-soluble fraction in five cakes per type of bird (silky fowl egg or hen), statistical analysis was performed using the unpaired student's t-test (KaleidaGraph, Ver. 4.0, Synergy software, PA, USA). Difference in the mean values among groups was assessed using the Tukey-Kramer multiple comparisons test (Instat Ver. 3.0, GraphPad software, Inc., CA, USA). The level of significance was set at $p<0.05$ for all statistical tests.

RESULTS AND DISCUSSION

Observation of height of sponge cake using silky fowl egg and using hen egg: An effect of whole silky fowl egg on the height of sponge cake was examined. Figure 1 showed the cross-sectional views of sponge cakes using silky fowl and using hen egg, respectively. The height of the sponge cakes using silky fowl egg was higher than that of the sponge cake using the hen egg. The average of height of a sponge cake using whole silky fowl egg was about 8 cm. A organoleptic evaluation of the baked sponge cake using whole silky fowl and using hen egg was respectively, examined. The sponge cake using silky fowl egg felt softer than the sponge cake of hen' egg, and the sponge cake using silky fowl egg softly a feeling, delicious and puffily than the sponge cake of hen's egg. Comprehensive evaluation of the sponge cake using silky fowl egg was higher than that of the sponge cake using the hen egg.

Rheologic properties of sponge cakes: A hardness and adhesion of the baked sponge cake using whole silky fowl and using hen egg was measured by a rheometer. After 2 days no change was observed in either type of egg at all. However, after 4 days, hardness of sponge cake using hen egg increased drastically. In contrast, in case of sponge cake using silky fowl egg, hardness of

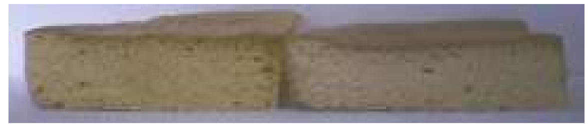

Fig. 1: Comparison of appearance and hight between sponge cake using silky fowl egg and hen egg

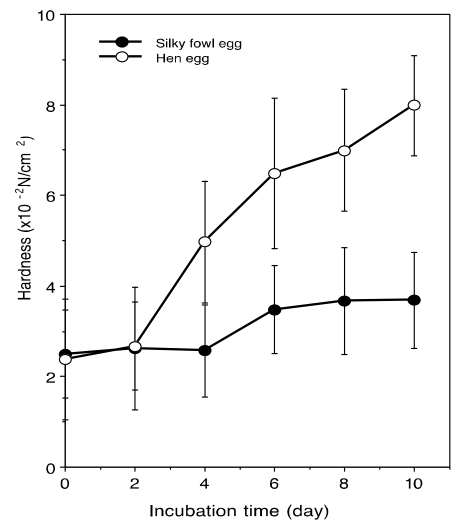

Fig. 2: Comparison of hardness of the sponge cake using silky fowl egg and hen egg for 10 days
Each value represents the mean ± standard deviation

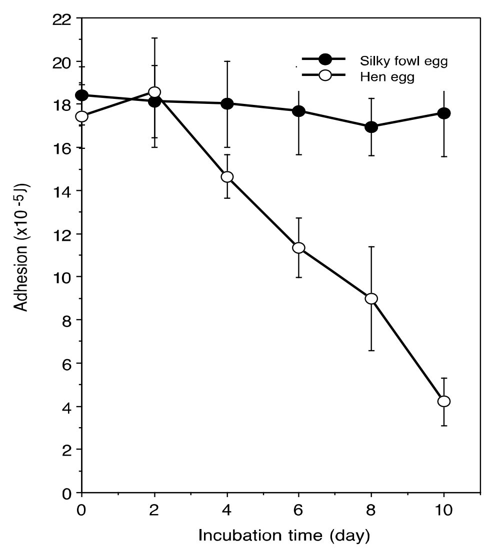

Fig. 3: Comparison of adhesion of the sponge cake using silky fowl egg and hen egg for 10 days
Each value represents the mean ± standard deviation

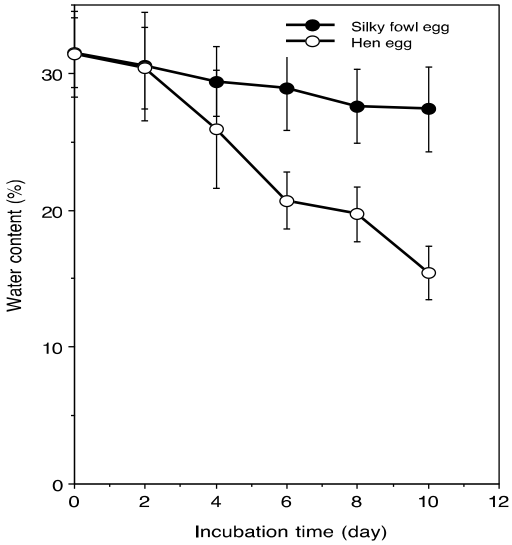

Fig. 4: The changes of water content of the sponge cake using silky fowl egg and hen egg for 10 days
Each value represents the mean ± standard deviation

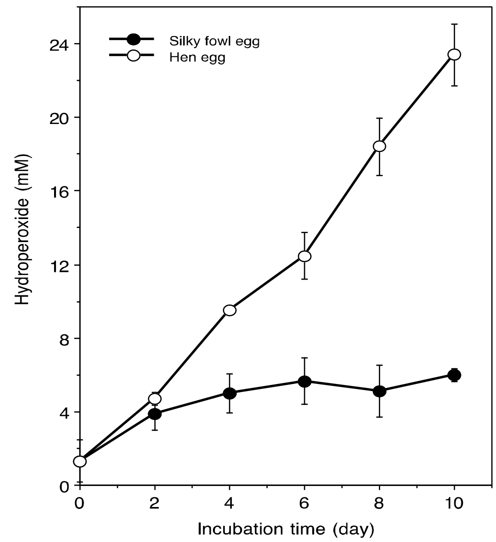

Fig. 5: Amount of hydroperoxide in sponge cake using silky fowl egg and hen egg for 10 days
Each value represents the mean ± standard deviation

the cake was hardly changed and then began to increase gradually (Fig. 2). Adhesion of the sponge cake using silky fowl egg and hen egg was examined. The sponge cake using silky fowl egg indicated no change of adhesion of the cake. In contrast, after 4 days, the cake of hen egg cake decreased adhesion for the cake drastically (Fig. 3). Addition of silky fowl egg in the sponge cake could maintain softness and adhesion of the sponge cake. Those results suggested that the effect of physical properties of silky fowl egg is responsible for the network structure for dough and egg proteins. However, it mechanism will be examined in detail in the future.

Comparison of water content of sponge cake: Figure 4 shows change of the water content in the sponge cakes. Sponge cake using silky fowl egg indicated hardly change for 10 days. In contrast, in case of sponge cake using hen egg, after 4 days the water content of the cake decreased drastically. In this case, it is speculated that the proteins of egg albumen contribute to the water retentivity of silky fowl egg. This phenomenon has not been clarified.

Oxidative stability of sponge cake: Figure 5 shows comparison of the oxidative stability between the cake using silky fowl egg and that using hen egg was investigated by amount of hydroperoxide. Hydroperoxide of sponge cake using silky fowl egg showed hardly change for 10 days. In contrast, in case of sponge cake using hen egg, the amount of hydroperoxides in the cake increased drastically during 10 days. Previously, it was reported that unsaturated fatty acids showed stronger ant oxidative activity than saturated fatty acids (Husain *et al*., 1986; Sugino *et al*., 1997). We reported that original silky fowl whole egg indicated significant oxidative stability of compared to hen egg, because of higher ratio of unsaturated fatty acids of silky fowl egg than that of hen egg (Toyosaki and Koketsu, 2004, 2008). The present results are consistent with the previous reports. We have separated and purified new antioxidants from Silky fowl egg. As a result, the antioxidant component in Silky fowl egg was estimated at 49.6 kDa fraction may be a protein-bound tocopherol (Toyosaki, 2012). There is a possibility that 49.6 kDa fraction is involved as antioxidants. Future, it is necessary to examine in detail in this regard.

Addition of silky fowl egg in the sponge cake could contribute to the quality maintenance of the cake such as softness adhesion and oxidative stability.

CONCLUSION

The current research demonstrated that rheological properties, and oxidative stability of baked sponge cake using silky fowl egg. From the results of this study it will be concluded that the use of silky fowl egg could improve a quality and rheological properties and oxidative stability of baked cakes. This result can submit knowledge to the food science field. From now on, you have to examine the differences in physical properties of the sponge cake and the mechanism of oxidative stability of silky fowl egg.

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