Advance Journal of Food Science and Technology 9(5): 342-345, 2015
DOI: 10.19026/ajfst.9.1912
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: March 2, 2015 Accepted: March 14, 2015 Published: August 20, 2015

Research Article

Property Assessment of Sponge Cake Added with Egg Replacer

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Abstract: Chicken egg which is always used in sponge cake production is likely to deteriorate during storage or transportation. This weakness prevents the wide use of chicken egg in sponge cake making. In order to solve this problem, egg replacer has been developed. In this study, effect of egg replacer on the property of sponge cake was analyzed. The result indicated egg replacer could improve the yield rate and specific volume of sponge cake. However, high content of egg replacer would negatively impact the internal structure and sensory property of sponge cake. Based on the result of this research, optimum content of egg replacer in sponge cake is 3.6 g. In the industrial production of sponge cake, different types of wheat flour and additives would be used. The optimum content of egg replacer may be different from the result of this research. Therefore, in the industrial production, the optimum content of egg replacer should be determined based on experiment.

Keywords: Egg replacer, property, sponge cake, wheat dough

INTRODUCTION

Egg, which contains high contents of essential amino acids and unsaturated fatty acids, is an important food ingredient (Saavedra *et al*., 2014). It is always used as a nutritional fortification substance in food, particularly cereal products. Furthermore, egg could be used to improve properties, such as specific volume, color and taste of bread and cake (Choi *et al*., 2012). It was reported that bread with high content of egg had much lower hardness value (He and Lu, 2014). With the development of food production technology, more and more highly valuable eggs, such as selenium-richeggs, omega-3 eggs and zinc-rich eggs, have been developed (Saavedra *et al*., 2014). Therefore, using egg as an ingredient to improve the nutrient value and property of food has become a hot topic.

Sponge cake is consumed by many people worldwide. Previous studies indicated that improving the property of sponge cake and preventing its deterioration during storage are two important research aspects (Rodríguez-García *et al*., 2012; Zhang *et al*., 2012). It was reported that sunset yellow and some synthetic foaming agents were used to improve sensory properties of sponge cake (Xu *et al*., 2014). However, the healthy problems caused by synthetic pigment and chemicals used in food have become much more serious. To solve these problems, now egg with highly valuable ingredients and foaming properties is always used in sponge cake production to replace the synthetic chemicals (Toyosaki and Sakane, 2013).

Previous studies revealed that perishable property of egg prevented it application in food industry. Furthermore, although egg is used to improve the nutrient value and sensory property of food, it could negatively impact the property of cereal products in storage and reduce the storage period (Tan *et al*., 2014). Therefore, more and more food companies are trying to use egg replacers in food production. The main aim of this study was to assess the property of sponge cake added with egg replacer. Firstly, specific volume of wheat dough and sponge cake added with different contents of egg replacer was measured. Secondly, yield rate of sponge cake was discussed. Thirdly, fuzzy mathematical model was used to assess the sensory property of sponge cake. Fourthly, changes of water content in sponge cake during storage were analyzed. Fifthly, microorganism colonies on sponge cake with different contents of egg replacer during storage were discussed.

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Table 1: Ingredients formula of sponge cake

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Wheat flour	100.0 g	101.8 g	103.6 g	105.4 g	107.2 g	109.0 g
Sugar	80 g	80 g	80 g	80 g	80 g	80 g
Egg	120 g	108 g	96 g	84 g	72 g	60 g
Egg replacer	0.0 g	1.2 g	2.4 g	3.6 g	4.8 g	6.0 g
Baking powder	1.5 g	1.5 g	1.5 g	1.5 g	1.5 g	1.5 g
Soybean oil	2.5 g	3.0 g	3.5 g	4.0 g	4.5 g	5.0 g
Water	0.0 g	9.0 g	18 g	27 g	36 g	45 g

Table 2: Evaluation criteria for the sensory score of sponge cake (based on GB/T 13868-2009 and SB/T10139-93) (Fan *et al*., 2009)

Items	Weight coefficient	Evaluation criteria
Exterior appearance	20%	Good: Crust is smooth; shape is symmetrical and stands upright. Medium: middling. Poor: crust is coarse; shape is asymmetrical and hard agglomerations occur.
Color	10%	Good: Yellow or light yellow. Medium: middling. Poor: gray or dark.
Structure	30%	Good: Pores of longitudinal cut side are small and symmetrical. Medium: middling. Poor: pores of longitudinal cut side are large and asymmetrical.
Elasticity	20%	Good: Good rebound after pressing with a finger, strong to the bite. Medium: middling. Poor: poor rebound after pressing with a finger, soft to the bite.
Taste	20%	Good: Has fragrance of wheat and pleasant taste. Medium: middling. Poor: unpleasant taste.
Total score	100%	

MATERIALS AND METHODS

Materials: Wheat flour was obtained from market of COFCO Group Co., Ltd (Zhengzhou, P.R. China). Dry yeast was purchased from Angel Yeast Co., Ltd (Zhengzhou, P.R. China). Egg replacer was obtained from Arla Foods Ingredients. Sugar, chicken egg, soybean oil and baking powder were purchased from local market.

Sponge cake production procedure: Wheat flour was mixed with certain amount of water, chicken egg, egg replacer, soybean oil and sugar. The contents of these ingredients were changed in different batches of experiment. These ingredients were mixed by agitator at 200 r/min for 12 min firstly. Then wheat flour and baking powder were added into agitator. Agitator was operated at 60 r/min for 30s and 200 r/min for 1 min. Wheat dough was put into baking mold and placed in oven at 170-190ºC for 10 min. After being baked, sponge cake was placed at room temperature for cooling down. The ingredient formula was shown in Table 1.

Analysis methods: Specific volumes of wheat dough and sponge cake were measured according to GB/T 24303-2009. Yield rate was calculated according to Eq. (1):

$$\text{Yield rate} = \frac{\text{Weight of final product}}{\text{Weight of raw materials}} \times 100\% \qquad (1)$$

Sensory property assessment: Sensory assessment of sponge cake was carried out according to a revised method based on GB/T 13868-2009 and SB/T10139-93. Detailed assessment criteria were shown in Table 2. Sensory property assessed by property evaluation team consisting of ten members. Members gave scores on five aspects of sensory property, including exterior appearance, color, structure, elasticity and taste. Average value was used to reflect the sensory property of sponge cake.

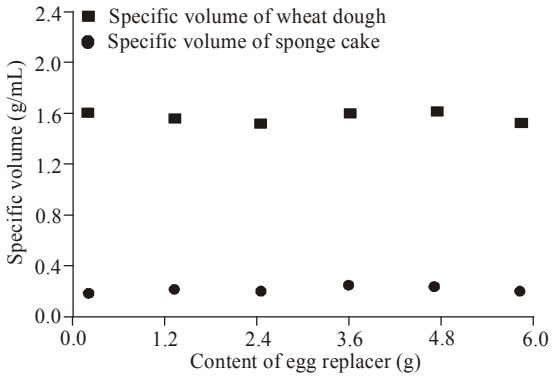

Fig. 1: Specific volume of wheat dough and sponge cake

RESULTSAND DISCUSSION

Specific volume of wheat dough and sponge cake: It was reported that specific volume of sponge cake was an important factor determining the sensory property. Generally, sponge cake with higher specific volume has better sensory property. The research of Miñarro *et al*. (2012) revealed that specific volume of baked product was determined by the specific volume of wheat dough (Miñarro *et al*., 2012). Therefore, effects of egg replacer on the specific volume of both wheat dough and sponge cake were analyzed in this section. Figure 1 indicated that specific volume of wheat dough decreased from 1.61 to 1.52 g/mL when the content of egg replacer increased from 0 to 2.4 g. This result indicated that egg replacer could not improve the property of wheat dough if the content of egg replacer was low. When the content of egg replacer exceeded 2.4 g, specific volume of wheat dough increased. Peak value of specific volume of wheat dough (1.62 g/L) was obtained when the content of egg replacer was 4.8 g. Specific volume of sponge cake increased with the addition of egg replacer and reached peak value (2.6 g/L) when the content of egg replacer was 3.6 g. When

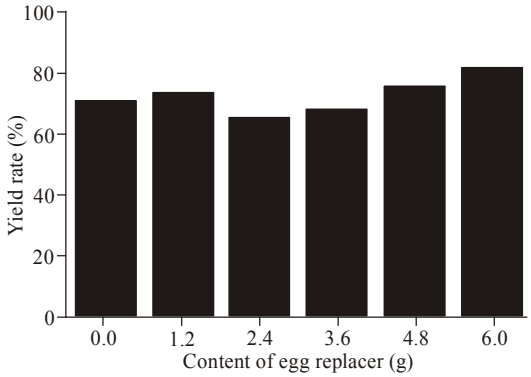

Fig. 2: Yield rate of sponge cake

the content of egg replacer exceeded 3.6 g, specific volume of sponge cake decreased significantly.

This result showed that egg replacer could improve the specific volume of wheat dough and sponge cake. One of the possible reasons is that the foaming action of some ingredients in egg replacer contributed to the increment of specific volume. Therefore, the foaming action of egg replacer should be much better than that of chicken egg. However, if the content of egg replacer with good foaming action reached high level, specific volume of wheat dough and sponge cake decreased significantly. It was reported that excessive foaming would lead to the collapse of internal structure of baking products. Therefore, the reason why the specific volumes of wheat dough and sponge cake were low when the content of egg replacer was high is that high content of egg replacer with good foaming action led to the collapse of internal structure of sponge cake. Therefore, in order to improve the specific volume of sponge cake, content of egg replacer should be controlled.

Yield rate of sponge cake: Figure 2 indicated that yield rate reached peak value (82%) when the content of egg replacer was 6 g. Yield rate when the content of egg replacer was 6 g was 11% higher than the yield rate when there was no egg replacer added. Therefore, egg replacer could be used to improve the yield rate of sponge cake. It was reported that in baking process water in wheat flour and chicken egg would evaporate. If water loss during baking is high, yield rate of sponge cake will decrease. Furthermore, the research of He and Lu (2014) revealed that sponge cake with low water content always had poor taste (He and Lu, 2014). Therefore, how to prevent the water loss in baking process is significant to the improvement of yield rate and the sensory property. The possible reason why sponge cake with 6 g egg replacer had higher yield rate was that water mixed with egg replacer could not evaporate easily during baking process. In the large scale production of sponge cake, high yield rate will not only improve the taste of sponge cake, but also bring a lot of financial profits to factory.

Internal structure of sponge cake: Internal structure of sponge cake with different contents of egg replacer was shown in Fig. 3. Pictures indicated that internal structure of sponge cake with 4.8 g egg replacer and 3.6 g replacer was much better than that of sponge cake with other contents of egg replacers. For instance, internal pores of egg replacer with 4.8 g egg replacer and 3.6 g replacer were fine and well distributed. Therefore, certain content of egg replacer in could improve the internal structure of sponge cake. The possible reason is that egg replacer powder could distribute in the wheat dough effectively while chicken egg could not be well distributed. Although agitator could distribute egg physically, the nutrients in egg could not be distributed effectively. As a result, ingredients with foaming action may not be well distributed in wheat dough. Accordingly, pores in sponge cake are not fine or well distributed. Therefore, to improve the internal structure of sponge cake, egg replacer powder could be used.

Sensory assessment of sponge cake: Scores of five aspects, including exterior appearance, color, structure,

Fig. 3: Internal structure of sponge cake with different contents of egg replacer

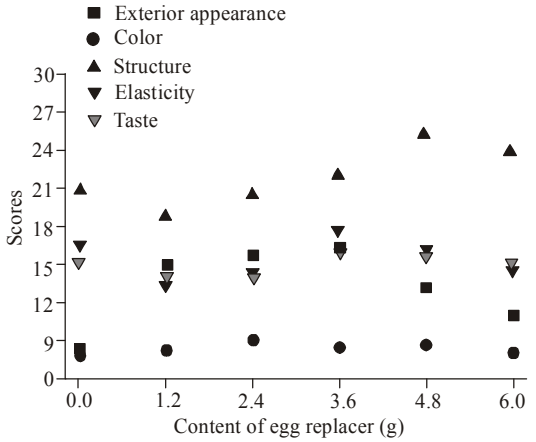

Fig. 4: Scores of five aspects in sensory property

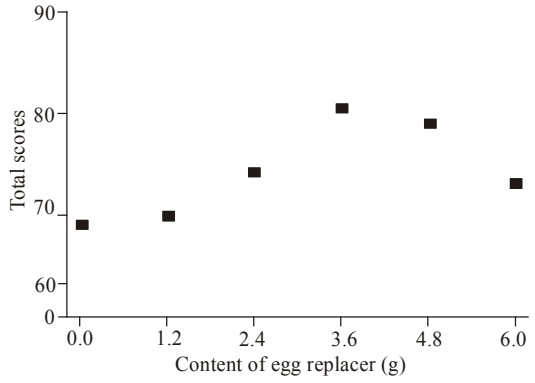

Fig. 5: Sensory assessment of sponge cake

elasticity and taste, were shown in Fig. 4. The result indicated that adding egg replacer into wheat dough in the production of sponge cake could improve the exterior appearance, color, structure, elasticity and taste. However, excessive content of egg replacer would lead to the decrement of scores on these aspects. Total score of sensory assessment was shown in Fig. 5. The result showed that the total score reached peak value (82.8) when the content of egg replacer was 3.6 g. When the content of egg replacer exceeded 3.6 g, total score decreased. Therefore, excessive content of egg replacer would negatively impact the sensory property of sponge cake. Based on the discussion above, to improve the sensory property of sponge cake, the content of egg replacer should be optimized. In the industrial production of sponge cake, some additives, such as natural pigments, which may impact the property of sponge cake, are always added. Therefore, the optimum content of egg replacer may be different from the result of this research.

CONCLUSION

The result of this study focusing on the property of sponge cake with egg replacer indicated that egg replacer could improve the yield rate and specific volume of sponge cake. However, high content of egg replacer would negatively impact the internal structure and sensory property of sponge cake. Based on the result of this research, optimum content of egg replacer in sponge cake is 3.6 g. In the industrial production of sponge cake, different types of wheat flour and additives would be used. The optimum content of egg replacer may be different from the result of this research. Therefore, in the industrial production, the optimum content of egg replacer should be determined based on experiment.

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