

Spring 2017

# Effects of Egg and Egg Replacers on Consumer Acceptability of Chocolate Cake

Stormey R. Trayter

*The University of Akron*, StormeyT@gmail.com

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## Recommended Citation

Trayter, Stormey R., "Effects of Egg and Egg Replacers on Consumer Acceptability of Chocolate Cake" (2017).

*Honors Research Projects*. 516.

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Effects of Egg and Egg Replacers on Consumer Acceptability of Chocolate Cake

The University of Akron

Stormey Trayter

**ABSTRACT**

Egg allergies are very common, and affect 1% to 2% of all children (Savage, 2007). For this reason, egg replacers that can be easily used by home cooks are an important area of research. In this experiment, a simple egg replacer of flour, oil, baking soda, and water was added to a standard cake mix, with variables consisting of a control product and a product made with no eggs using the egg replacer. The null hypothesis was rejected; removing eggs and adding the egg replacer has an effect on the ability for consumers to discriminate between samples in a triangle test.

*Keywords:* whole-egg, egg replacers, chocolate cake mix, sensory analysis, triangle test

## INTRODUCTION

The goal of this study is to determine if a simple homemade egg replacer, made with ingredients found in most home kitchens, will create an acceptable product. This information will be beneficial to many, including those with egg allergies. Desserts and baked goods, when eaten in moderation are an important part of American culture. We have cake for birthdays, weddings and other celebrations. People, especially children, can feel left out when they are unable to partake in these rituals. If the product is acceptable, the simple egg replacer will allow a greater number of people to create baked products that can be shared with their friends and family who are allergic to eggs, even if they do not keep other egg replacers on hand.

This project's goal is to determine the acceptability of an egg free product, specifically a chocolate cake using a discriminative triangle test. If there is no significant difference in the two products found after data analysis, the product made with the egg substitution will be found to be acceptable.

## REVIEW OF CURRENT LITERATURE

Eggs are notoriously difficult to replace due to their unique properties and functional uses. An egg has four primary functional purposes: coagulation, the ability to foam, emulsification and contributing ingredients (Yang & Baldwin, 1995). Lesser functions of eggs are providing flavor and color to a product (Yang & Baldwin, 1995). The protein of egg whites provides structure, by toughening as the product coagulates (Vaclavik, 2014). Egg yolks function as emulsifiers due to the high lipoprotein content (Vaclavik, 2014).

Unfortunately, egg allergy is very common and affects 1% to 2% of all children (Savage, 2007). Some of these children go on to gain a tolerance to egg products later in life. (Savage,

2007). In addition to the physical aspect, the social impact of a food allergy on a child can be large. The 2006 study “The impact of food allergy on the daily activities of children and their families” used a food allergy impact scale to assess caregiver’s perception of the implications of the child’s food allergy on eight daily family activities (Bollinger, 2006). These eight activities included meal preparation, family social activities, caregiver-supervised child social activities, autonomous child social activities, school activities, family relations, and caregiver stress, free time, employment and finances. One hundred and one caregivers were approached, of these, 87 caregivers completed the questionnaire (Bollinger, 2006). Approximately 35% of the food-allergic children were African-American, 56% were white, and 10% were of other races. The sample was 52% male and 48% female, ranging in age from 8 months to 17 years. No socioeconomic data were collected. The data showed a significant impact of food allergy on almost all aspects of daily life, with the largest being daily meal preparation (Bollinger, 2006). Furthermore, the study showed that over half of the participants believe food allergy significantly affected their family social activities, and one-third of the caregivers reported that food allergy had an impact on their child’s school attendance (Bollinger, 2006).

The 2013 cross-sectional survey “Allergic Diseases in Preschoolers Are Associated with Psychological and Behavioural Problems” found that there is a strong correlation between allergy disease and behavioral problems in preschoolers with three major allergic diseases, asthma, allergic rhinitis, and atopic dermatitis (Chang, 2013). Data was collected using a modified “International Study of Asthma and Allergies in Childhood” questionnaire and the “Child Behaviour Checklist” to assess behavior and sleep problems in children (Chang, 2013). This study approached the parents of 780 preschoolers aged 3-7 years old, from 17 preschools that were randomly selected from Seoul and Ilsan and Gwacheon in Gyeonggi-do province in

Korea (Chang, 2013). Of those approached, parents of 780 preschoolers from 13 preschools consented to participate in the psychological evaluation. The results showed that preschoolers who had been treated for asthma in the past 12 months had higher anxiety scores (Chang, 2013). Preschoolers with atopic dermatitis had higher scores for attention problems and attention deficit hyperactivity disorder (Chang, 2013). Allergic rhinitis has been previously shown to be associated with internalizing problems in adults, results from this survey show that this correlation also exists in the preschoolers studied (Chang, 2013). Of the three types of allergic diseases, all were positively correlated with behavioral problems (Chang, 2013). The correlation between allergic rhinitis and atopic dermatitis and behavioral problems in preschoolers was especially strong (Chang, 2013).

These studies demonstrate the detrimental effect allergies can have on children. Acceptable egg replacements have the potential to improve the quality of life of those with egg allergies. This section will now examine previous experiments in replacing eggs in cakes; including whey protein and gums and bovine plasma as a low-cost replacement for dried egg whites in layer cakes (Kohrs, 2010, Lee, 1993).

In the 2010 study of whey protein and gum, yellow cakes were made with egg replacers substituted at the levels of 50% and 100% of the dried whole eggs in the yellow cake system (Kohrs, 2010). Two combinations of wheat gums were used: guar/whey/starch and xanthan/whey/starch (Kohrs, 2010). The products were subjectively evaluated using a 6-point hedonic scale. Results found that at 50% substitution, treatments performed closer to that of the control compared to 100 % substitution. The combination of xanthan/whey/starch was found to be significantly higher in acceptability than the combination of guar/whey/starch (Kohrs, 2010).

A study by C.C. Lee, J.A. Love and L.A. Johnson in 1993 looked at the sensory and physical properties of cakes in which dried egg white products were replaced with varying levels of spray-dried bovine plasma (Lee, 1993). The study found that dried egg white could be replaced with bovine plasma without reducing the total volume of the cake. However, there were significant differences in symmetry, shrinkage, color, and textural characteristics between the control product and the high-ratio bovine plasma product. Subjective testing found that consumers liked the cakes prepared with bovine plasma as well as the control product, despite the differences, showing that plasma protein products are a cost-effective egg substitute that can be used in layer cakes without adverse effects on sensory qualities (Lee, 1993).

The food science text, “Food Science, An Ecological Approach” by Sari Edelstein, PhD., RD, put forth an egg replacer consisting of flour, oil, water, and baking powder (Edelstein, 2010). The flour provides protein, the oil provides lipid content, and the baking powder provides extra lift to prevent the product from becoming too dense (Edelstein, 2010). These ingredients work in tandem to create a facsimile of an egg. No research was included on the application of this egg replacer. This project therefore seeks to determine the acceptability of a product made with this egg replacer.

## MATERIALS AND METHODS

The procedure followed for this experiment was to prepare four identical Betty Crocker™ Supermoist™ Cake Mixes, in the flavor Chocolate Fudge. The two control products were prepared according to the package directions (General Mills, 2017). The modified product was prepared with egg replacer mixture in place of egg and was otherwise prepared according to package directions. Equipment used for this procedure includes four identical 9" x 13" disposable tin pans, two rubber spatulas, nonstick cooking spray, two convection ovens with

timers, two large glass mixing bowls, and liquid and dry measuring cups. The equipment was provided by the Food Lab in Schrank Hall South, at The University of Akron. The products were also prepared and baked in this lab. Both ovens were preheated to 350 degrees Fahrenheit. The four 9" x 13" pans were sprayed with nonstick spray on the bottom of the pan only.

The experiment was conducted one time and not repeated. The two control products were each made with a 1 ¼ cup of cold tap water, a ½ cup of Crisco pure vegetable oil and 3 Giant Eagle brand, grade A, large eggs. The two variable products were each made with a 1 ¼ cup of cold tap water, a ½ cup of Crisco pure vegetable oil and the egg replacer. The egg replacer was made with 2 tablespoons white all-purpose flour, ½ tablespoon Crisco pure vegetable oil, 2 tablespoons of water and ½ teaspoon of baking powder per egg (Edelstein, 2010). This mixture was well blended before being added to the product. The recipe called for three eggs, therefore the recipe for the egg replacer was tripled for each of the variable products.

A sensory panel was conducted with 38 sensory panelists ranging in age from 18-40. The products were compared subjectively by a discriminative triangle test. The purpose of the triangle test was to have panelists distinguish between the three variables, and see if they could pick out the sample which was different. The four samples were coded using four three-digit codes: 129, 493, 592 and 775. Codes 129 and 493 were the experimental products. Codes 592 and 775 were the control products. Each panelist was given a plate containing two samples that were the same and one which was different. The samples were placed in a randomized triangle pattern on each plate (Table 1). If there is no significant difference in the two products after data analysis is done, the product made with the egg substitution will be found to be acceptable.

Table 1.1 - *Possible Combinations of Sample Plates*

Similar	Differing	Differing Type	Samples of this Type Served
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Samples	Samples		
129 493	592	Control	10
129 493	777	Control	9
592 775	129	Variable	11
592 775	493	Variable	8
Total:			38

## RESULTS

The null hypothesis posed for this experiment was that the egg replacement would not cause a change in the ability to discriminate between the samples. If each sample has an equal chance of being selected by the panelist, the probability of selecting the differing sample correctly is 1 in 3. Therefore, the percentage of correct answers must fall with  $P < .005$  difference of the null hypothesis to hold the null hypothesis.

Table 1.2 - *Triangle Test Results*

	<i>Expected</i>	<i>Observed</i>
<i>Correct Respondents</i>	~12.6	26
<i>Incorrect Respondents</i>	~25.3	12
<i>Total Respondents</i>	38	38

The observed number of correct responses was 26 of 38 or approximately 68.4%. The expected number of correct responses, which was approximately 12.6 of 38, or 33%. Comparing the observed and expected outcome a value of  $p=2.052$  difference was found. Thus, the null

hypothesis did not hold, and the two products were found to be dissimilar. This experiment was conducted once with a total of 38 panelists.

## DISCUSSION

This project's goal is to determine the acceptability of an egg free product, specifically a chocolate cake using a discriminative triangle test. The null hypothesis posed for this experiment was that the egg replacement would not cause a change in the ability to discriminate between the samples. The null hypothesis is rejected by this project's findings. Therefore, the experimental product was not found to be acceptable (Table 2). Further adjustment of the egg replacer ratio of ingredients may lead to a more acceptable product. This study only examines a single type of baked product, chocolate cake made from a prepackaged mix. To determine the results in other product, further experiments must be done.

Several limitations of this study should be noted. First, possible experimental error due to lack of sample size. There is also the possibility of stimulus error inherent in the triangle test due to the difference in the appearance of the two products. The triangle test only determines whether the two products can be discriminated from each other. Further research could utilize subjective sensory testing using a 9-point hedonic scale to determine the likability of experimental products as compared to the control.

Alterations in the ratio and type of ingredients used in the egg replacer are also possible areas of future research. Subjects of interest include higher protein flours, such as bread flour, or even concentrated wheat gluten, which may work to provide more structure to the product.

## CONCLUSION

The product made using the egg replacer, as put forth in the text “Food Science, An Ecological Approach” was found to be significantly different from the control product, and was not found to be acceptable according to the study’s parameters.

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