



SPONGE CAKE APPLICATION RESEARCH

COMPARING THE FUNCTIONALITY OF EGGS TO EGG REPLACERS IN SPONGE CAKE FORMULATIONS

SPONGE CAKE RESEARCH EXECUTIVE SUMMARY

Starting with a gold standard sponge cake formula containing eggs as the Control sample, researchers reduced and/or removed eggs from the formula and replaced them with a number of commercial egg replacer products. Egg replacers were used at the manufacturers' suggested rates. Analytical tests and organoleptic sensory evaluations were performed on each sponge cake formula.

Overall, not a single product performed as well as or better than real eggs in all attributes assessed. The egg replacers varied widely in functionality. A soy-based egg replacer performed most similarly to the Control, but had a more open cell structure and paler color. Wheat, whey protein concentrate and fiber-based products performed poorly, resulting in dry, weak sponge cakes with low aroma and off-putting flavors. The Negative Control, made without eggs or replacers, was the lowest ranking formula in almost every test, resulting in pale, squat, fragile cakes with poor aroma and flavor. These tests confirm that sponge cakes need eggs or egg replacers in formulation to perform functionally. Manufacturers must test egg replacers and spend time optimizing formulas for acceptable results.



OBJECTIVE

The purpose of the study was to provide food manufacturers research-based formulation and application information on the use of egg replacers in sponge cakes. Due to the many performance contributions of real eggs in sponge cakes, it was hypothesized that no single ingredient would be able to replace the multiple functions provided by eggs in sponge cake without affecting product quality.

EGG REPLACING INGREDIENTS

After researching egg replacers, seven egg replacer ingredient companies were selected, based on dollars spent on marketing and advertising in industry publications. A variety of egg replacing ingredients was selected based on recommended use to reduce or replace whole eggs in sponge cake. Ingredient specifications, nutritionals, starting formulations and recommended usage rates were collected from the manufacturers and used to create test formulas. Egg replacers not recommended for this application were excluded from testing.

The recommended egg replacement varied from 20 to 100 percent and almost all recommended keeping the ratio of moisture to dry ingredients the same. (When removing some or all of the liquid eggs from a formula, moisture is also removed, so it needs to be added back in the form of water to balance the formula.) Only two companies recommended removing 100 percent of the eggs from sponge cake formulas. Different egg replacer ingredients have varying water absorption capacities. If an ingredient absorbs an excessive amount

of water, additional water may need to be added to the formula to obtain the correct batter viscosity to flow through production equipment. Additionally, this can lengthen bake times to get the correct internal temperature and final moisture content.

FORMULAS

Control/Gold Standard Formulas

The Control formula consisted of cake flour, granulated sugar, salt, baking powder, emulsifier, liquid whole eggs, water, and vanilla extract.

Negative Control

A test was conducted with the absence of eggs or egg replacers to demonstrate the need for the functionality of these ingredients.

Test Formulas

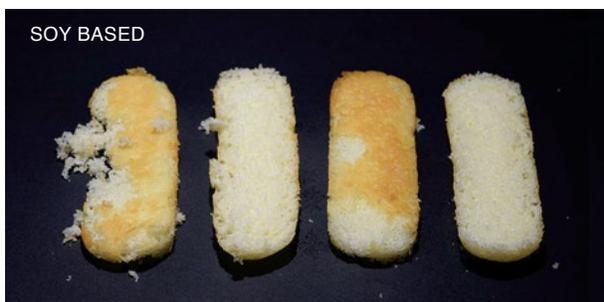
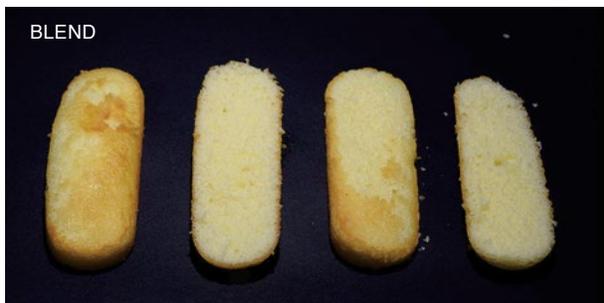
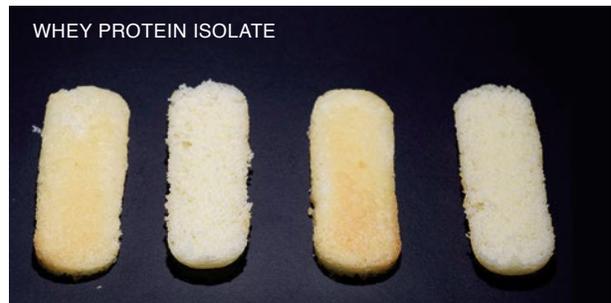
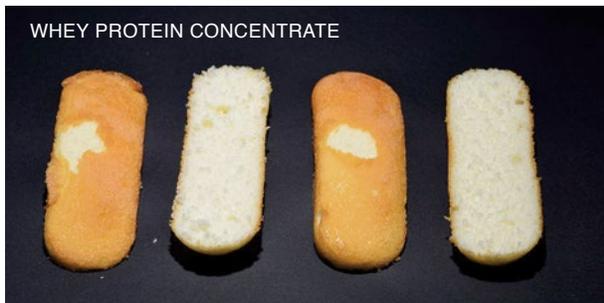
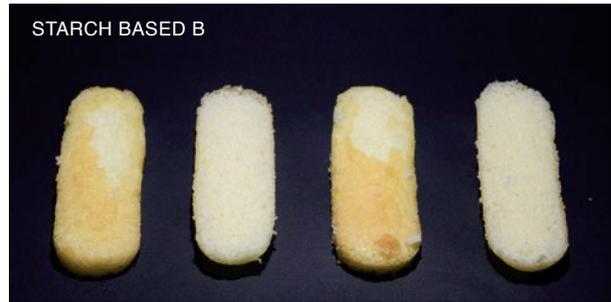
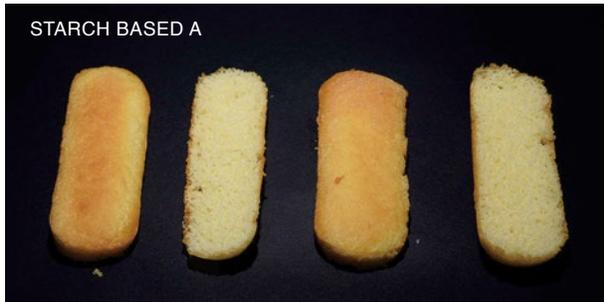
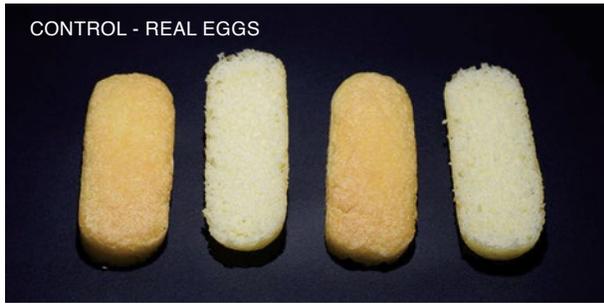
Seven egg replacers were tested in sponge cake formulas. Egg replacers tested included:

- Starch-based blend
- Soy-based blend
- Whey protein concentrate
- Wheat protein isolate
- Blends of various ingredients
- Fiber-based blend

Sponge cake test formulas were created using cake flour, granulated sugar, salt, baking powder, emulsifier, liquid whole eggs, water, vanilla extract, and the egg replacer ingredients. Formulations were based on the ingredient manufacturer's recommended percent in application and percentage of whole egg replacement, and varied widely.



SPONGE CAKE VISUAL COMPARISON



TESTS

Both the batter and cooked, cooled cakes were analyzed using industry standard, category-specific tests. Sponge cakes were all baked in the same conditions, in the same oven, on the same day. Consistent batching, portioning, and baking procedures were used to limit variables. Each test was batched in the same mixer using standardized mixing procedures. The pans used were identical and each was prepared for portioning in the same manner. Bake times were not adjusted or optimized for each test formula, instead a standardized time and temperature was used to ensure each test saw the same conditions. They were cooled for 10 minutes before being de-panned and stored in poly bags. Batter analytical tests were performed immediately after mixing, while tests performed on the baked sponge cakes were performed after they had cooled completely.

Testing was performed at the CuliNex Seattle Test Kitchen and AIB International Laboratories in Manhattan, Kan.

Tests used to assess sponge cake batter and finished cakes:

Analytical Tests

- Batter specific gravity (BSG)
- Batter viscosity
- Baked good height/shape
- Color
- Texture
- Moisture
- Water activity (A_w)

Subjective/Sensory Tests

- Cooked appearance
- Cell structure
- Cooked aroma
- Texture
- Flavor
- Overall likability

RESULTS & DISCUSSION

BATTER QUALITY

Batter Specific Gravity

Almost all test samples were similar to the BSG value of Control. This suggests that while all egg replacers did function to help aerate the batter, they range in functionality.

Batter Viscosity

Viscosities of the Test sponge cake batters varied significantly from very thick to thinner, with the Control in the middle. Therefore, some egg replacers impacted the batter viscosity significantly, and the moisture content of the formula would need to be optimized in order for batter to flow through machinery properly to be deposited evenly into pans. This could potentially result in longer bake times to reach target internal temperatures.

BAKED GOOD APPEARANCE

Baked Good Height/Shape

All Test samples had lower rise than the Control, at both the center and the edge. This suggests that although some egg replacers were able to produce batters similar to Control in BSG and viscosity, the effects did not hold up upon baking, resulting in uneven poorly risen cakes. While Negative Control had the same BSG as Control, it had the lowest rise of all the tests. This demonstrates the need for eggs or egg replacing ingredients to attain proper rise and shape in sponge cakes.



Cooked Appearance & Color

Control had the highest rated appearance, “even light brown exterior” and a “good even crumb.” Over the course of testing, most samples remained relatively the same in terms of appearance.

EATING QUALITY

Cooked Aroma

Control had appropriately strong aroma intensity and highly rated aroma likability scores over the course of testing. Negative Control had the weakest aroma over all three days of testing. Test formulas varied in aroma likability and intensity with most being positive or neutral. These results imply that formulas with real eggs and/or egg replacers all performed better than the formula without any egg or replacer.

Moisture & Water Activity

The moisture content and A_w values indicated that the egg replacers were as effective at binding water in the sponge cake matrix as eggs.

Texture

Control scored a five on Day 1, as ‘neither dry or crumbly nor moist and gummy,’ and as “tender with a slight chew.” Over the course of the tasting days, Control degraded to a sensory score of a four on Day 20, with panelists describing it as “stale, very dry, structure intact, but crumbles in mouth.” In sensory evaluation, Test sample texture varied, with some being perceived as moister and others drier than Control. All test samples degraded to some extent by Day 20.

Flavor

Flavor intensity of Control was consistently rated throughout testing as having ‘neither bland nor strong flavor,’ and having the highest flavor likability score on Day 1. However, the flavor likeability of Control decreased over time, and by Day 20 it was rated ‘slightly unappealing’ with “eggy, stale” notes. Egg replacer samples were rated in flavor likability downward from slightly appealing. Ratings decreased over time as staling occurred.

Overall Likability

Over the course of testing, all samples decreased in overall likability scores. On Day 1, no Test matched Control in overall likability, with its even and high rise, golden color, open cell structure and sweet flavor. However, by day 20, Control was downgraded and several egg replacers had surpassed it in overall likability by a slight margin.

CONCLUSIONS

The use of ingredients to reduce or replace eggs in sponge cakes is challenging for even the most accomplished baker. The sensory evaluation results from panelists on the organoleptic attributes of the sponge cakes are consistent with the findings of the objective analytical test results. The areas of sponge cake quality most negatively affected when eggs are removed and/or replaced included batter viscosity, color/appearance and texture.

Tasters unanimously preferred the Control to the Test formulas at the start of testing.



Its golden brown color, high rise, even top, uniformly open cell structure, and sweet, eggy baked good aroma and flavor won panelists' approval as the most appealing sponge cake.

It was neither dry nor moist, and its structure was tender in the mouth, yet firm and pleasant to chew.

Egg replacers varied vastly in both analytical tests and sensory evaluation results. The egg replacer Test most closely resembling Control in many attributes was the soy-based product. While it did not promote aeration of the batter as well as Control and was thicker, it baked up into cakes that were rated very similarly to Control. It was slightly paler in color, had an even rise and open cell structure, but was downgraded over time for becoming moist on top. Overall, this egg replacer scored slightly higher on the last day of testing than Control for being slightly fresher tasting.

Unfortunately, few generalizations about egg replacers can be made, because they vary vastly from supplier to supplier. Even though ingredient manufacturers may have usage rate recommendations and even starting formulations, many do not know how their product performs in a variety of applications. Manufacturer recommendations for incorporating egg replacers into formulas can be vague and hard to follow, making product optimization through the use of egg replacers a time-consuming exercise.

Formulators must determine the best ingredients for sponge cakes through hands-on testing on the bench and in the plant to achieve the desired results, balancing cost with functionality and flavor. Ultimately, that may mean using real eggs in sponge cake formulations.

COMPLETE RESEARCH REPORT & FINDINGS

For a copy of the complete 55-page research report with further study background and detailed findings, please contact Elisa Maloberti at info@RealEggs.org or call 847.296.7043.





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