

SWEET DOUGH APPLICATION RESEARCH

COMPARING THE FUNCTIONALITY OF EGGS TO EGG REPLACERS IN SWEET DOUGH FORMULATIONS

SWEET DOUGH RESEARCH EXECUTIVE SUMMARY

For this study, eggs were reduced and/or removed from sweet dough formulas and replaced with commercial egg replacer products at the manufacturers' suggested rates. Sweet dough eating quality was evaluated quantitatively and qualitatively. While egg replacers varied in functionality, not a single product performed as well as or better than real eggs. Overall, changes in quality from the reduction or removal of egg products in sweet dough are slight, but noticeable. The areas of sweet dough quality most negatively affected when eggs are removed and/or replaced included dough quality and baked good color, crumb size, aroma, flavor and texture. The highest performing egg replacers were a soy-based product and a whey protein concentrate-based product, although panelists found these products to be neither appealing nor unappealing. The egg replacer that performed most differently from Control was the whole algal flour product, particularly in color, texture and flavor. Manufacturers must test egg replacing ingredients 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 sweet dough. Due to the known performance characteristics of real eggs in sweet dough, it was hypothesized that no single ingredient would be able to replace the multiple functions provided by eggs in brownies without affecting product quality.

EGG REPLACING INGREDIENTS

After researching egg replacers, five 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 sweet dough. 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 50 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 needed to be added back in the form of water to balance the formula). Two companies recommended removing 100 percent of the eggs from the sweet dough formula. 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 dough quality and desired product attributes.

FORMULAS

Control/Gold Standard Formulas

The Control formula consisted of bread flour, pastry

flour, water, whole eggs, margarine, granulated white sugar, nonfat dry milk powder, dry active yeast and salt.

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

Five egg replacer ingredients were tested in sweet dough formulas. Egg replacers tested included:

- Soy-based blend
- Whey protein concentrate
- Wheat protein isolate
- Whole algal flour

Sweet dough test formulas were created using bread flour, pastry flour, water, whole eggs, margarine, granulated white sugar, nonfat dry milk powder, dry active yeast, salt and the egg replacer. Formulations were based on ingredient manufacturers' recommended percent in application and percentage of whole egg replacement, and varied widely.

TESTS

Raw dough and cooked, cooled rolls and cinnamon buns were analyzed, using industry standard, sweet dough-specific tests. Sweet dough rolls used in analytical tests were made without fillings or toppings to reduce variables. Sweet dough cinnamon buns were used for organoleptic sensory testing, as consumers are accustomed to tasting sweet dough in an application, such as cinnamon buns. Rolls were stored in sealed poly bags, while cinnamon buns were stored in their original foil tins with plastic cling wrap overwraps and plastic lids.

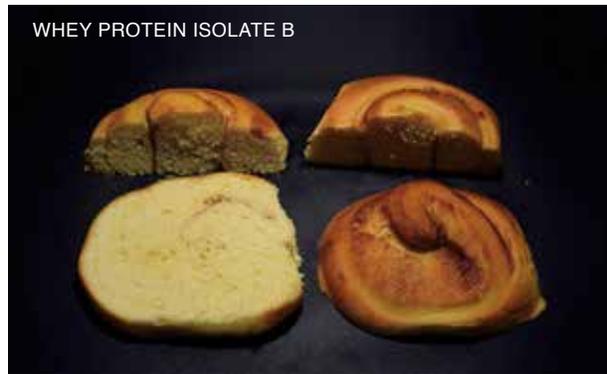
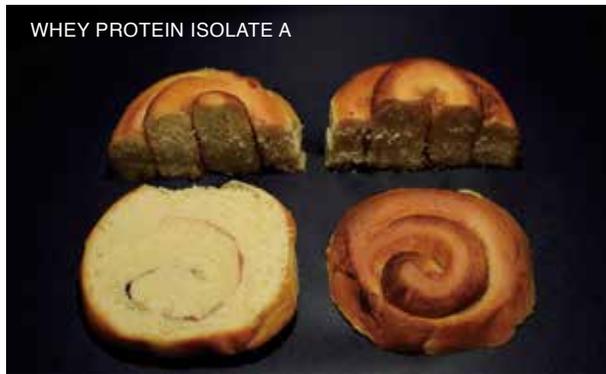
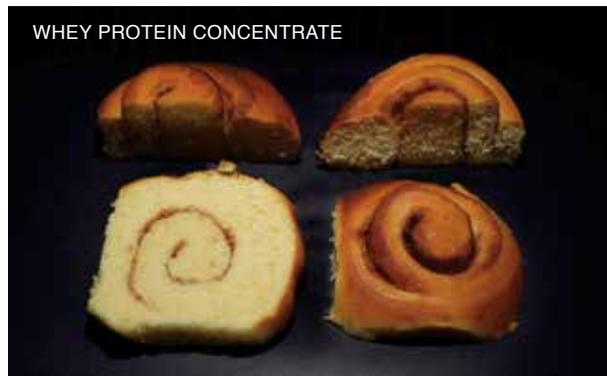
Testing was performed at the CuliNex Seattle Test Kitchen and AIB International Laboratories in Manhattan, Kan.

Analytical Tests

Dough temperature
Baked good shape
Color



SWEET DOUGH VISUAL COMPARISON



Texture
Moisture
Water activity (A_w)

Subjective Dough Test

Windowpane

Subjective/Sensory Tests

Cooked appearance
Crust color
Crumb color
Crumb size
Crumb uniformity
Cooked aroma
Texture
Flavor
Overall likability

RESULTS & DISCUSSION

DOUGH QUALITY

All tests were in the target dough temperature range after mixing completion. Control formed a sticky, very soft ball of dough that was fully developed, exhibited through a windowpane test. Negative Control formed a firm, springy dough ball that was difficult to shape, indicating that without eggs, there may have been excessive gluten development. Most of the Tests behaved similarly to Negative Control, being firm and tough, but not fully developed after the mixing time, being unable to pass a windowpane test. Many Tests were dry and flaky looking, even though the water was adjusted based on manufacturer recommendations. This exemplifies that moisture content needs to be balanced when using replacers and that egg replacers may interfere with proper gluten development.

BAKED GOOD APPEARANCE

Baked Good Shape

All Tests were close to Control in height, while

the diameters differed more among the samples. Negative Control was one of the largest samples, indicating that without eggs to interfere with gluten development, the dough was very strong. These results show that egg replacer performance varies, depending on the source material and that additional, moisture content of the formula has a direct effect on the sweet dough shape.

Exterior Appearance

The exterior appearance of the rolls varied among the Test formulas and even among rolls from the same pan. These variations in color and shape were likely due to being hand-formed on the bench rather than machine-produced and should be taken into account when evaluating sensory test results. Significant changes in appearance were not likely to occur between days one and four of testing, and as such, the average score over the two test days is a better indicator of quality (rather than evaluating changes in appearance over time).

Appearance

On both days of testing, Negative Control was the highest rated sample—being ‘moderately appealing,’ and described as “look[ing] light and pillowy, really pretty and puffy, like a well-made bakery roll.” Over the course of testing, most Tests decreased or remained the same in appeal rating. Appearance appeal in Control was rated ‘neither appealing nor unappealing.’

Crust Color

The sensory evaluation results for crust color of the cinnamon buns mostly aligned with colorimeter test results of the rolls, with the exception of Control. Control cinnamon buns were described as being “very nicely browned, deeply golden” and were rated the darkest sample by panelists. However, the colorimeter results differed slightly, indicating that Control rolls fell in between the other Tests.

INTERIOR APPEARANCE

Crumb Color

The crumb color of Control was described as “slightly yellow, as expected” and was rated ‘slightly light/neither light nor dark.’ Crumb color varied



among the Test samples with many scoring close to Control. Negative Control was found to be lacking in color.

Crumb Appearance

In sensory evaluation, the crumb of Control was rated as moderately sized and neither too uniform nor too uneven, as were Negative Control and one of the Tests. Negative Control had a slightly larger, more uneven crumb structure than Control, with one panelist commenting, “some very large cells, a bit larger than expected.” The other Tests were rated as having small or very fine, even crumb structure.

EATING QUALITY

Cooked Aroma

Over the two days of testing, average aroma intensity for all Tests ranged between slightly faint to slightly strong. Some of the Tests decreased in aroma intensity over the course of the tastings, including Negative Control, while others increased in intensity, including Control.

Control had the highest average aroma likability scores, being scored, ‘moderately appealing.’ It was described as “as expected” and “slightly sweet aroma with hints of cinnamon.” Control was the only sample to have increased aroma likability scores on the last day of testing, whereas all the egg replacer Tests had fairly significant decreases in likability scores.

Moisture & Water Activity

Average moisture content of samples was fairly similar. Moisture content did not fluctuate very much over the course of testing, except for within one Test sample. The change in moisture in the remaining Tests was insignificant, however the sensory panelists rated all samples being slightly to moderately dry and as becoming more dry over time. The sensory scores for moisture generally aligned with the moisture analysis results. These results suggest that egg replacers function similarly to eggs in binding water in sweet dough applications, but consumers may correlate differences in texture due to staling to moisture loss over time, even if actual percent moisture has not decreased.

Texture

Over the shelf life, all samples increased in crumb firmness and most decreased in crumb resilience, as expected due to the staling process. The texture of Control was rated ‘neither tender nor chewy’ on Day 1 and described as having “some structure and chew, but not tough” and being “fairly tender.” By Day 4, Control was perceived as becoming “a bit tough” and “stale.” The crumb firmness scores aligned with sensory results.

Flavor

Flavor intensity scores did not change significantly over the course of testing. All Tests had average intensity scores ranging from ‘neither weak nor strong’ to ‘slightly strong.’ Control was rated ‘neither weak nor strong’ and described as “fairly mild,” and “not too sweet.” It had the highest flavor likability scores and was described as being “as expected” with “no off flavors” and a “very pleasant baked good flavor.” Negative Control scored closest to Control and was described as “not as complex,” but that it did not have any off flavors. Flavor likability scores among the Test samples ranged from ‘neither appealing nor unappealing’ to ‘moderately unappealing.’

These results suggest that sweet dough made with reduced egg content may lack the characteristic of “sweet baked good flavor.” Additionally, egg replacers may contribute unappealing flavors out of place in a sweet dough application.

Overall Likability

All Tests decreased in likability over the course of testing, mostly due to texture changes associated with staling. Negative Control and Control scored the highest average scores over the course of testing, rated as ‘neither unappealing nor appealing.’

CONCLUSIONS

The use of ingredients to successfully reduce or replace eggs in sweet dough can be challenging for even the most accomplished baker. The sensory evaluation results from panelists on the organoleptic attributes of the sweet dough



were consistent with the findings of the objective analytical test results. The areas of sweet dough quality most negatively affected when eggs are removed and/or replaced, include dough quality, color, crumb size, aroma, texture and flavor. A_w values were not significantly different among the samples, even with different proportions of water in formulations based on manufacturers' recommendations.

Tasters rated Control more appealing than the egg replacer Tests in most attributes assessed. It had a dark brown crust and golden yellow, evenly sized and open crumb with an appealing aroma. Panelists commented that Control had the most characteristic "sweet baked good" flavor, as expected in a sweet dough application. Negative Control had higher scores than Control in appearance and overall likability, due to its tall rise, and larger, more irregular crumb structure. However, these attributes are not characteristic of an enriched sweet dough. Negative Control also lacked proper yellow color, typically found in sweet dough applications. Panelists found both Control and Negative Control to be moderately dry in texture, but thought Control lost too much moisture by the second day of testing, whereas Negative Control actually increased in moisture content according to moisture analysis test results. This is due to the fact that Negative Control had a higher level of water in its formula to make up for the lack of eggs. Both Control and Negative Control had the highest rated average flavor likability scores, for 'slightly appealing,' but decreased in appeal over time, whereas Control actually experienced an increase in rating over time.

Egg replacer Tests varied in both analytical tests and sensory evaluation results, with some products performing similarly to Control and others markedly different. The egg replacers that performed most similarly to Control were the soy and whey-based products, respectively.

The two wheat-based egg replacers were found to be slightly unappealing in overall likability by panelists. Both had dry, tough dough that never fully developed and produced slightly smaller rolls with more dense, compact crumb structure. Overall, while the wheat-based egg replacers shared some similar attributes in dough quality and crumb

structure, they produced different results in sweet dough, neither of which were particularly appealing to panelists.

The egg replacer that performed most poorly in a sweet dough application was the algae-based product. The dough was very tough and sticky, inhibiting gluten development and resulting in small, dense, unappealing rolls. They had the lowest moisture content and the firmest crumb, indicating the moisture content of the dough needed optimizing. Both the crust and crumb were noticeably more yellow than any other Test, being deemed out of place even in a typically golden sweet dough. The algae replacer contributed unappealing aroma and flavor notes, including vegetal, chemical and artificial qualities that were undesirable in a sweet baked good.

It can be difficult to make generalizations about egg replacers because they vary vastly from supplier to supplier. Even though ingredient manufacturers may have usage rate recommendations and some starting formulations, many do not know how their product performs in a variety of bakery 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 sweet dough 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 sweet dough formulations.

COMPLETE RESEARCH REPORT & FINDINGS

For a copy of the complete 59-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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