



BLUEBERRY MUFFIN APPLICATION RESEARCH

COMPARING THE FUNCTIONALITY OF EGGS TO EGG REPLACERS IN BLUEBERRY MUFFIN FORMULATIONS

BLUEBERRY MUFFIN RESEARCH EXECUTIVE SUMMARY

For this study, eggs were reduced and/or removed from peak-top blueberry muffin formulas made with a crème cake muffin base and replaced with commercial egg replacer products at the manufacturer's suggested rate. The samples were evaluated quantitatively in commonly used cake analytical tests and then qualitatively in organoleptic tests. Sensory panelists unanimously preferred the Control to the Test formulas. Overall, not a single product performed as well as or better than real eggs, but a fiber-based egg replacer came closest. The lowest performer was a whole algal flour egg replacer, which suffered from an excessive yellow color, weak texture, and off flavors. Except for batter specific gravity and muffin height, all other areas of muffin quality were affected, especially flavor and texture. Other products including starch, soy, whey protein concentrate and wheat-based products did provide some functionality to muffin formulas, but did not meet or exceed the Control organoleptically in acceptability. To fully assess egg replacers, manufacturers must test them on the bench 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 crème cake muffins. Due to the many performance contributions of real eggs in bakery products, it was hypothesized that no single ingredient would be able to replace the multiple functions provided by eggs in crème cake muffins without substantially affecting product quality.

EGG REPLACING INGREDIENTS

After researching egg replacers, nine egg replacer ingredient companies were selected, based on dollars spent on marketing and advertising in industry publications. A variety of egg replacers was selected based on recommended use to reduce or replace whole eggs in muffins. 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 25 to 100 percent, and almost all manufacturers 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 decreased and 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 muffin 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.

FORMULAS

Control/Gold Standard Formulas

A commercially-available crème cake muffin mix, requiring only the addition of water and dried or liquid eggs, was used in testing to standardize ingredients and limit variables.

Negative Control

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

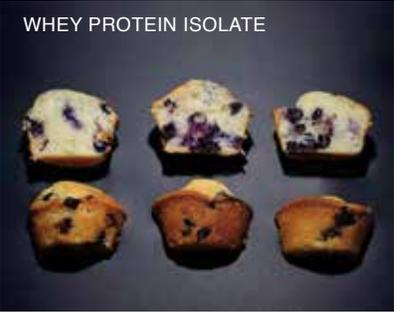
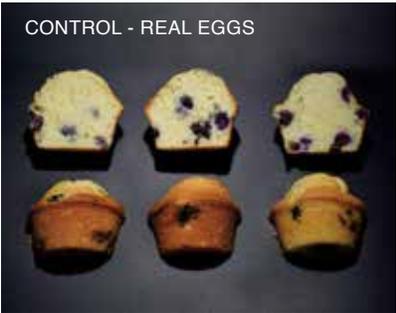
Test Formulas

Nine egg replacers were tested in blueberry muffin formulas, including:

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



BLUEBERRY MUFFIN VISUAL COMPARISON



TESTS

Both the batter and cooked, cooled muffins were analyzed, using industry standard, category-specific tests. Muffins were all baked in the same conditions, in the same oven, on the same day. They were cooled for 10 minutes before being de-panned, and stored in plastic muffin trays wrapped in standard plastic cling wrap. Batter analytical tests were performed immediately after mixing, while tests performed on the baked muffins were performed after they had cooled completely.

Analytical Tests

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

Subjective/Sensory Tests

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

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

RESULTS & DISCUSSION

BATTER QUALITY

Batter Specific Gravity

All samples were close to the BSG value of Control, except Negative Control, which had a significantly higher BSG, meaning it was much denser than Control. This suggests that all of the egg replacers did provide function to help the aeration of the batter, and therefore the density of the batters was close to the Control made with real eggs.

Batter Viscosity

All samples were more viscous than Control. While many fibers and functional ingredients have high water absorption capacities, they can vary drastically among ingredients, even of the same type (i.e. oat or citrus fiber) due to variances in processing. Batters that are too thick will be difficult to mix thoroughly and could result in uneven distribution of inclusions (such as blueberries) and could cause trouble getting the batter to flow through depositing machinery. The water content would need to be adjusted to optimize formulas, which may result in the loss of other functionalities.

BAKED GOOD APPEARANCE

Baked Good Height & Shape

All egg replacer tests were fairly close to the height of Control in the center, with



Negative Control being the shortest. This shows that eggs and/or egg replacers are necessary to achieve the desired muffin rise.

Most of the egg replacer tests were close to the diameter of the Control made with real eggs. Negative Control, the sample made without any eggs or egg replacers, performed very poorly, exhibiting that the egg replacers do perform functionally in creating proper height and shape in muffins.

Cooked Appearance & Color

On all days of testing, Control was rated significantly more appealing than all the other Tests. Control had a large, round, well-defined peak shape and an open-grained texture. Test sample results varied widely from 'moderately appealing' to 'very unappealing'. Negative Control had the lowest appearance scores.

EATING QUALITY

Cooked Aroma

Cooked aroma intensity and likability did not change perceptibly over time. Control was rated as having had a moderately strong, extremely appealing aroma, smelling slightly sweet and fruity. No Test was rated as appealing as Control.

Moisture

On all days of testing, Negative Control had significantly less moisture than the others. Negative Control had less moisture because it contained no eggs or egg replacers, and therefore less water was bound in the matrix of the muffin and driven off during the baking process. The moisture content exhibited that the egg replacers were as effective, or more effective at binding water in the matrix as eggs.

Water Activity

Water activity was not significantly impacted by the used of egg replacers. While a lower water activity is associated with increased shelf life, it can come at the expense of eating quality; the Negative Control (which had much lower water activity than all the other samples) scored very poorly in sensory analysis.

Texture

Control had the highest rated texture in sensory evaluation, rated as neither dry/crumblily nor moist/gummy, across all testing days. The texture of Control changed very little over time. It also maintained the highest crumb resilience score on all testing days. Over the course of testing, all muffins appeared to have some moisture migration as tops became moister.

Flavor

No Test matched Control in flavor likability.

Overall Likability

Flavor and texture seemed to be the two biggest indicators of overall likability, and no Test matched Control in overall likability.

CONCLUSIONS

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



Tasters unanimously preferred the Control to the Test formulas.

Its symmetrical, even peaks, open-grained texture, and sweet, blueberry-forward aroma and flavor won panelists' approval as the most appealing muffin.

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

Egg replacers did contribute functionality to peak-topped muffin formulas. All of the egg replacers promoted aeration and were similar in BSG values to Control, while Negative Control did not have adequate aeration. Egg replacers also impacted batter viscosity, with all of the egg replacers producing batters that were more viscous than Control.

Even with increased batter viscosities, all Tests were fairly close to the height of Control in the center, except for Negative

Control, which was very squat and flat. This shows that egg replacers do perform functionally in batter aeration, which results in characteristic height and shape in muffins.

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 muffins 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 muffin formulations.

COMPLETE RESEARCH REPORT & FINDINGS

For a copy of the complete 56-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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