



# FROZEN WAFFLE APPLICATION RESEARCH

COMPARING THE FUNCTIONALITY OF EGGS TO EGG REPLACERS IN FROZEN WAFFLE FORMULATIONS

# FROZEN WAFFLE RESEARCH EXECUTIVE SUMMARY

For this study, eggs were reduced and/or removed from frozen waffle formulas and replaced with commercial egg replacer products at the manufacturers' suggested rates. Then both the batter and cooked, reheated waffles were evaluated using common industry analytical tests and qualitatively. The changes to frozen waffles with reduced egg content were slight, but noticeable.

Overall, not a single egg replacer product performed as well as or better than real eggs in all attributes assessed, but a couple products performed similarly. A blended ingredient product and a fiber-based egg replacer performed most closely to the Control, but both had muted flavor and were starchier tasting than expected. Other samples tested included, blended ingredient products and fiber-, soy- and dairy protein-based products. All of the waffles made with replacers varied in appearance, aroma and flavor, but were generally not as appealing in flavor as Control.

The Negative Control, made without eggs or replacers, performed poorly in almost every test. The waffles produced were pale, earthy-tasting and had a gummy texture. This confirms frozen waffles need the functionality of eggs or egg replacers in their formulation for the best batter and eating quality results. Manufacturers must test egg replacing ingredients and spend time optimizing formulations 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 frozen waffles. Due to the known performance characteristics of real whole eggs in waffles, it was hypothesized that no single ingredient would be able to replace the multiple functions provided by eggs in waffles without affecting product quality.

# EGG REPLACING INGREDIENTS

After researching available egg replacers, eight 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 their recommended use to reduce or replace eggs in frozen waffles. Ingredient specifications, nutritionals, starting formulations and recommended usage rates were requested and compiled from the manufacturers and used to create test formulas. Egg replacers not recommended for this application were excluded from testing.

The recommended whole egg replacement for frozen waffles varied from 50 to 100 percent; almost all recommended keeping the ratio of wet to dry ingredients the same (when removing some or all of the liquid whole eggs from a formula, moisture is also removed, therefore needing to be added back in the form of water to balance the formula). Five of the eight manufacturers recommended removing 100 percent of the whole eggs from frozen waffle formulas.

# FORMULAS

## Control/Gold Standard Formulas

The Control formula consisted of water, high protein bread flour, liquid whole egg, canola oil, granulated sugar, nonfat dry milk solids, baking powder and salt.

## Negative Control

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

## Test Formulas

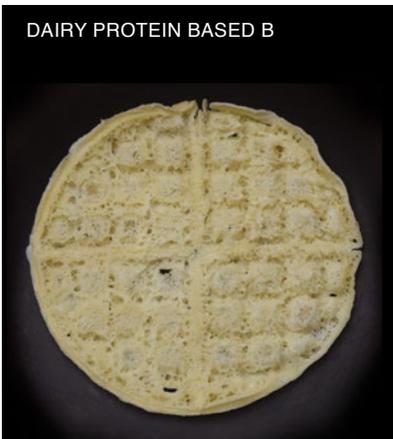
Eight egg replacer ingredients were tested in frozen waffle formulas. Egg replacers tested were:

- Blends of various ingredients, including starches, proteins, emulsifiers, leaveners, enzymes and hydrocolloids
- Wheat protein-based
- Fiber-based
- Soy-based
- Dairy protein-based

Frozen waffle test formulas were created using the Control gold standard formula, with the addition of egg replacer ingredients and any suggested changes to water content. No further optimization was done. Formulation changes were based on the ingredient manufacturer's highest recommended usage rate in application and percentage of whole egg replacement, which varied widely among products.



# FROZEN WAFFLE VISUAL COMPARISON



# TESTS

Both the batter and cooked, reheated waffles were analyzed using industry standard, category-specific tests. The waffles were all prepared in the same conditions, in the same model equipment, on the same day. Consistent batching, mixing, portioning and cooking procedures were used to limit variables. The waffle irons and toasters used were the same models, and each was set to the same settings. Baking and toasting times were neither adjusted nor optimized for each Test formula, instead a standardized time and temperature setting was used to ensure each Test saw the same conditions. Batter analytical tests were performed immediately after mixing, while tests on the waffles were done after they were frozen and reheated.

Testing was carried out at the CuliNex Seattle Test Kitchen and Medallion Labs in Minneapolis, Minnesota.

## Analytical Tests

- Batter specific gravity
- Batter viscosity
- Color
- Texture
- Moisture

## Subjective/Sensory Tests

- Appearance
- Color
- Cell structure
- Aroma
- Texture
- Flavor
- Overall commentary

# RESULTS & DISCUSSION

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## BATTER

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### Batter Specific Gravity

All Tests except for the Negative Control were not significantly different from Control BSG. The Negative Control was slightly denser than the Control, suggesting that all egg replacing ingredients did function to aerate the batter effectively.

### Batter Viscosity

Six Tests had significantly different batter viscosities than the Control waffle batter. Of those, two were less viscous than Control, while the others were more viscous. The other Test formulations did not have significantly different viscosities than Control. This suggests egg replacer performance related to batter viscosity varies drastically, depending on the source material and functionality of the egg replacer.

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## WAFFLES

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### Appearance

Commentary from panelists was varied, with toasting differences affecting panelists' ability to differentiate among the samples. It was noted Control was golden in color, with a smooth "attractive"-looking surface and "lots of holes from air bubbles." Negative Control was described as looking underdone and pale, with a somewhat grey hue and a waterlogged appearance. However, statistical analysis shows, there was no significant difference between the organoleptic ratings of either crumb size or uniformity among any of the samples.



## Color

Most Tests were similar in colorimeter analysis to Control, with some Tests being slightly lighter and others darker. Overall, some color differences among samples were noticed, with slight variations due to inconsistencies in toasting, but significant differences in color were noticeable to panelists in some samples with reduced egg content.

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## EATING QUALITY

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### Aroma

Most aroma commentary indicated waffle aroma intensity was not significantly affected by egg reduction, however the characteristic egg aroma was generally decreased and some off aromas were detected in a few samples. In summary, some egg replacers may contribute mild off aromas to frozen waffles.

### Moisture

Moisture content of most Tests was not significantly different from that of Control. These results suggest moisture is not significantly impacted by egg replacement, if the water in the formula is adjusted based on manufacturer recommendations.

### Texture

Only one egg replacer sample was significantly different than Control in hardness, being significantly less hard than Control. All other samples, including Negative Control were not significantly different than Control, suggesting hardness is not generally affected by the removal of eggs or the addition of egg replacers. Three samples were significantly higher than Control in measures of cohesiveness.

Yet another measure of texture was springiness, which yielded different results than hardness and cohesiveness tests. Three Tests had significantly higher springiness values than Control. However, chewiness, a measure of the combined texture

analysis scores previously discussed, showed no samples were significantly different from Control. This was also true of the sensory analysis scores, with ratings indicating the samples were not significantly different from one another. These results suggest while there may be changes in texture due to the use of egg replacers in waffles with reduced egg content, those differences may not result in perceptible changes to eating quality.

### Flavor

The flavor of Control was described as tasting of eggs and vanilla, and having a sweet baked good flavor, without any off flavors. The sample made without eggs, Negative Control, was noticeably lacking in flavor, according to panelists. Comments ranged from “tastes like bread flour,” “strange lingering aftertaste,” to “something earthy about it.” The egg replacer Tests were generally also reduced in flavor intensity, with noticeably decreased egg flavor and with some having off flavors not expected in waffles. Overall, the commentary suggests waffles with reduced egg content may have reduced flavor intensity and may not meet consumer expectations in flavor profile.

### Overall Commentary

Panelists were in agreement that Control was the best-tasting sample. The Negative Control was found to be less appealing than Control by all panelists, due to its pale color and off aroma and flavors. Commentary regarding the remaining Test samples varied among the panelists.

## CONCLUSIONS

The changes to frozen waffles with reduced egg content were slight, but noticeable. The sensory evaluation results from panelists on the organoleptic attributes of the waffles tested were generally consistent with the findings of the objective analytical test results. The areas of waffle quality most negatively affected when eggs are removed and/or replaced include batter viscosity, waffle



appearance, color, aroma and flavor. Attributes where differences among samples were minimal included BSG, waffle crumb size/uniformity, moisture and texture.

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Tasters unanimously preferred the Control to the Test formulas. Its golden-brown color, slightly sweet, eggy baked good aroma & flavor won panelists' approval as the most appealing frozen waffle.

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ingredient manufacturers may have usage rate recommendations and even starting formulations, many do not know how their product performs in a variety of applications. Their 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 frozen waffles 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 frozen waffle formulations.

## COMPLETE RESEARCH REPORT & FINDINGS

For a copy of the complete 60-page research report with further study background and detailed findings,

please contact Elisa Maloberti at [info@RealEggs.org](mailto:info@RealEggs.org) or call 847.296.7043.



The Negative Control sample with neither eggs nor egg replacing ingredients was found to be different from Control in multiple ways. The batter was thinner and denser, exemplifying that eggs function to aerate waffle batter. The cooked waffle looked pale to sensory panelists, who picked up some off aromas and flavors. These results imply frozen waffles made without eggs nor egg replacers may be unappealing to consumers. Of the egg replacers tested, there were two products that produced waffles similar to Control.

Unfortunately, few generalizations about egg replacers can be made, because they vary vastly among manufacturers. Even though





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