REALEGGS

BROWNIE APPLICATION RESEARCH

COMPARING THE FUNCTIONALITY OF EGGS TO EGG REPLACERS IN BROWNIE FORMULATIONS

RESEARCH SUMMARY

BROWNIE RESEARCH EXECUTIVE SUMMARY

For this study, eggs were reduced and/or removed from brownie formulas and replaced with commercial egg replacer products at the manufacturers' suggested rates. Brownie 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 in all attributes assessed. Overall changes in quality from the reduction or removal of egg products in brownies were slight but noticeable. The areas of brownie quality most negatively affected when eggs were removed and/or replaced included height, appearance, aroma, texture and most significantly, flavor. Moisture, batter specific gravity and A_w were not significantly different among the samples, indicating egg replacers do not considerably impact these attributes.

Tasters unanimously preferred the Control to those made without eggs and/or egg replacer products. Brownies made with egg replacers or without eggs had decreased aroma and some off-flavors that consumers may find unappealing. The highest performing egg replacer was a starch-based product, although panelists found it to be only slightly appealing. Brownies made with egg replacers that were deemed unappealing to panelists, included the whey protein concentrate and whole algal flour products, both of which contributed off-putting flavors to the brownies. Starch-based and blended-ingredient products were neither appealing nor unappealing to panelists. 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 brownies. Due to the known performance characteristics of real eggs in brownies, 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, six 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 brownies. 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 suppliers 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.) Two companies recommended removing 100 percent of the eggs from the brownie 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 batter viscosity to flow through production equipment. Additionally, this can lengthen bake times to achieve the correct internal temperature and final moisture content.

FORMULAS

Control/Gold Standard Formulas

The Control formula consisted of bread flour, granulated white sugar, natural cocoa, margarine, milk, whole eggs, vanilla extract, salt and baking powder.

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

Six egg replacer ingredients were tested in brownie formulas. Egg replacers tested were:

- Starch-based blend
- Whey protein concentrate
- Blends of various ingredients
- Whole algal flour

Brownie test formulas were created using bread flour, granulated white sugar, natural cocoa, margarine, milk, whole eggs, vanilla extract, salt, baking powder, water and the egg replacer. Formulations were based on the egg replacing ingredient manufacturer's recommended percent in application and percentage of whole egg replacement, which varied widely.

TESTS

Both the batter and cooked, cooled brownies were analyzed using industry standard, brownie-specific tests. Brownies were all baked in the same conditions, in the same oven, on the same day. They were cooled completely before being stored in their tins with a plastic cling overwrap and plastic lid. Analytical tests were performed on the brownie batter immediately after mixing, and further analytical and organoleptic tests were performed on the baked brownies after they had cooled completely.

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

BROWNIE VISUAL COMPARISON

Analytical Tests

Batter specific gravity (BSG)
Baked good height
Texture
Moisture
Water activity

Subjective/Sensory Tests

Cooked appearance
Color
Cooked aroma
Texture
Flavor
Overall likability

RESULTS & DISCUSSION

BATTER QUALITY

Batter Specific Gravity

All Test samples had relatively similar BSG values—which were either slightly lower or higher than Control. This suggests some egg replacers may promote more aeration of brownie batter than others, but ultimately the changes are slight, indicating egg replacers do not have a significant effect on brownie batter aeration.

BAKED GOOD APPEARANCE

Baked Good Height/Shape

All of the samples exhibited a shape that was slightly lower in height in the center than on the edge of the brownie tray, including Control. However, Control had the most even rise of all the samples. While most of the Test formulas had similar edge height measurements to Control, they were all lower in the center, with a somewhat concave appearance.

The Negative Control had the most irregular rise. These results show that egg replacer performance varies, depending on the source material, and that blended ingredient products may contribute to an uneven rise in brownies.

Cooked Appearance & Color

Over the course of the seven-day test period, all of the samples scored higher in appearance appeal on the first day of testing than on the last. Most of the samples were perceived as becoming slightly less shiny and lighter in color over time. The exceptions were Negative Control and one of the Tests, which were both rated slightly darker on Day 7 than on Day 1.

Control was rated more appealing than all Tests on all days of testing. Panelists described it as having a “defined, swirled looking top with some light colored striations, very even edge to edge with a fudgy-looking center,” but with a “somewhat dry looking edge.” On Day 1 of testing, Control was rated as having a ‘very appealing appearance’ and was described as having a “just right color,” being rated ‘neither pale nor dark.’ However on Days 4 and 7 of testing, Control was downgraded in appearance to ‘slightly appealing.’ This may have been because panelists perceived Control becoming lighter over time.

Overall, the visual differences between samples were slight, but noticeable. These results indicate that although egg replacers do contribute appropriately to brownie appearance, color and crust shine, consumers may not find these samples nearly as appealing as brownies made with real eggs.

EATING QUALITY

Cooked Aroma

While cooked aroma likability decreased in all samples over the course of testing, cooked aroma intensity fluctuated among the samples, with some becoming stronger over time and others decreasing in intensity over time. Although both the aroma intensity and likability of Control decreased over the course of testing, it was the highest rated sample in both attributes. It was rated as having a ‘slightly strong’ and ‘moderately appealing’ aroma that was described as “just right” and “classic brownie smell” by panelists.

After Control, the next highest rated Test in aroma intensity and likability was Negative Control, indicating that egg replacers may have a negative effect on brownie aroma likability and intensity.

Moisture & Water Activity

Throughout testing, all samples had fairly similar moisture contents to one another and all decreased slightly over time in both analytical and sensory tests, as would be expected. At the start of testing, all samples were described by panelists as having a slightly drier crust/exterior and moister interior, as would be expected in a bar-type cookie such as a brownie. The A_w of the all the brownie Tests was not significantly different from each other.

Control had the highest average moisture content, although panelists did not identify it as the moistest sample in sensory evaluation. The results suggest that some egg replacers did function to bind water in the brownie matrix better than the brownie made with eggs, but these differences may not be discernable to consumers.

Texture

With the exception of Negative Control, the texture of most of the samples remained relatively stable over time, a desirable attribute in baked goods. Sensory analysis scores aligned with analytical test results, indicating differences in texture among the samples were noticeable to panelists. Control was rated as 'neither cakey nor chewy' and fell in the middle of the range of crumb firmness scores of all the Tests. Panelists described it as "a little cakey with chewy edges" and "great, as expected for a brownie."

Results indicate egg replacer functionality varies and can have a significant effect on brownie texture and eating quality.

Flavor

Flavor intensity and likability scores remained relatively stable throughout testing. All samples were somewhat similar in flavor intensity, ranging from 'slightly strong' to 'very strong.' On the contrary, flavor likability varied quite a bit between samples, ranging from 'very unappealing' on the low end to 'moderately appealing' on the high end of the range.

Control was described as having an "as expected brownie flavor with well-rounded cocoa notes" and had the highest scores in flavor likability. It was rated as having 'moderately strong, moderately appealing' flavor on all days of testing. By Day 7, panelists commented the flavor of Control had slightly diminished in intensity, specifically that the chocolate flavor was not as strong. All brownies were rated as having a 'slightly strong flavor' or higher. Results suggest that flavor is generally weaker and less appealing in brownies made without eggs.

Overall Likability

Overall likability scores closely mimicked flavor likability scores, indicating that it was the most important indicator of product quality. Control had the highest average score over the course of testing. Comments from panelists included "overall, a great brownie" and "as one would expect to find in the bakery section of a grocer," but also noted that the crust color "seemed a little light" on the last day of testing, which contributed to a minute decrease in overall likability scores over time.

Egg replacer samples varied in overall likability from 'moderately appealing' to 'very unappealing' on Day 1, but decreased over time.

CONCLUSIONS

The use of ingredients to successfully reduce or replace eggs in brownies can be challenging for even the most accomplished baker. The sensory evaluation results from panelists on the organoleptic attributes of the brownies were consistent with the findings of the objective analytical test results. The areas of brownie quality most negatively affected when eggs are removed and/or replaced included height, appearance, aroma, texture and flavor. Moisture, BSG and A_w were not significantly different among the samples, indicating egg replacers do not considerably impact these attributes.

Tasters unanimously preferred the Control to the Test formulas on all days of testing, but did downgrade it slightly over time for a perceived

lightening of crust color. Its even rise, intense chocolate aroma, balance of cakey/chewy textures and well-rounded classic brownie flavor won panelists' approval as the most appealing brownie. Although panelists did perceive the crust color to become slightly lighter over time, the Control remained relatively stable in all other attributes assessed over the course of testing.

The brownie formula made without eggs, Negative Control, was markedly different than Control. It had a much darker, shinier crust, and had the most irregular rise of all the samples, being the most concave in shape. Aroma was similar to Control, but panelists thought it lacked flavor. Unlike Control, the Negative Control had the greatest change in texture over time, starting out as chewy on Day 1 and becoming cakey and described as "pasty" by the end of testing. Ultimately, panelists found Negative Control to be neither appealing nor unappealing.

Egg replacer Tests varied in both analytical tests and sensory evaluation results. One of the starch-based egg replacers performed most similarly to Control, and even so, panelists only rated it as 'slightly appealing' in overall likability. It produced brownies with slightly darker crust color and a lower rise in the center than Control. The aroma was slightly less intense and less appealing, and the texture was perceived to be drier.

Two other egg replacers that were neither appealing nor unappealing to panelists were the two blended ingredient products. Both had the higher A_w scores than other Tests, but as previously stated, the results were not significant. Panelists thought both Tests had slightly intense, slightly appealing aromas and slightly appealing flavors.

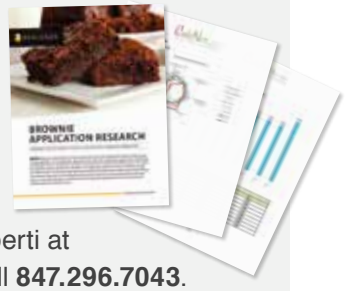
The whey-based egg replacer was similar in appearance to Control, but the crust became lighter and drier looking over time. It had a more firm, slightly chewy texture and a moderately strong, slightly unappealing flavor that resulted in a slightly lower overall likability score than the starch-based or blended ingredient egg replacer Tests.

The egg replacer that performed most poorly in a brownie application was the algae-based product. The sample was slightly darker and less smooth than Control, but did have an even rise from center to edge, garnering a rating of 'slightly appealing' by panelists. The aroma was slightly less appealing than that of Control and the texture was fatty/slimy feeling in the mouth. Additionally, its flavor was the most intense, and it was the least appealing sample in likability. Panelists found it to be extremely off-putting, with artificial and vegetal notes. Ultimately, the functionality gained by using the algae egg replacer did not offset the loss in flavor quality.

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 brownies 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 brownie formulations.

COMPLETE RESEARCH REPORT & FINDINGS



For a copy of the complete 52-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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