



CHOCOLATE CHIP COOKIE APPLICATION RESEARCH

COMPARING THE FUNCTIONALITY OF EGGS TO EGG REPLACERS IN CHOCOLATE CHIP COOKIE FORMULATIONS

CHOCOLATE CHIP COOKIE RESEARCH EXECUTIVE SUMMARY

For this study, eggs were reduced and/or removed from chocolate chip cookie formulas and replaced with commercial egg replacer products at the manufacturers' suggested rates. Chocolate chip cookie 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 chocolate chip cookies are slight but noticeable. Areas of cookie quality most negatively affected when eggs were removed and/or replaced, included aroma, flavor, texture, and to a lesser extent, color and appearance. The highest performing egg replacers were a starch-based product and an algal flour-based product, although panelists found these products to be neither appealing nor unappealing. Cookies that were deemed unappealing to panelists included those made with another starch-based product, a fiber-based product and a blended ingredient product, due to differences 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 chocolate chip cookies. Due to the many performance contributions of real eggs in cookies, it was hypothesized that no single ingredient would be able to replace the multiple functions provided by eggs in chocolate chip cookies, without affecting product quality.

EGG REPLACING INGREDIENTS

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

Recommended egg replacement varied from 25 to 100 percent. Six companies recommended removing 100 percent of the eggs from the chocolate chip cookie formula. Almost all of the egg replacer suppliers suggest replacing the eggs with a one-to-one ratio to dry eggs.

FORMULAS

Control/Gold Standard Formulas

The Control formula consisted of pastry flour, margarine, chocolate chips, granulated white sugar, brown sugar, water, dried whole eggs, vanilla extract, salt and baking soda.

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 replacer ingredients were tested in chocolate chip cookie formulas. Egg replacers tested were:

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

Chocolate chip cookie test formulas were created, using pastry flour, margarine, chocolate chips, granulated white sugar, brown sugar, water, dried whole eggs, vanilla extract, salt, baking soda and the egg replacer ingredients. Formulations were based on ingredient manufacturers' recommended percent in application and percentage of whole egg replacement, and varied widely.

TESTS

The cooked, cooled cookies were analyzed, using industry standard, cookie-specific tests. Cookies were all baked in the same conditions, in the same oven on the same day. They were cooled for 10 minutes before being removed from the sheet and stored in sealed poly bags. Analytical tests were performed on the baked cookies after they had cooled completely.

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

Analytical Tests

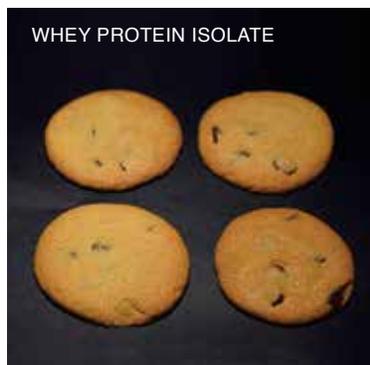
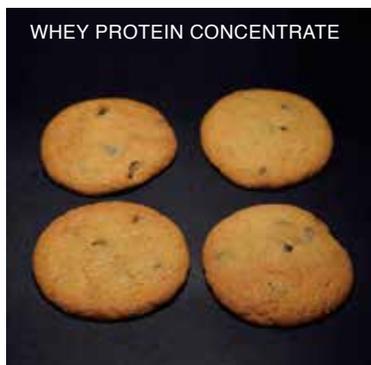
Baked good shape
Color
Texture
Moisture
Water activity (A_w)

Subjective/Sensory Tests

Cooked appearance
Cooked aroma
Texture
Flavor
Overall likability



CHOCOLATE CHIP COOKIE VISUAL COMPARISON



RESULTS & DISCUSSION

BAKED GOOD APPEARANCE

Baked Good Height/Shape

All egg replacer Test samples were similar in height to Control. One egg replacer produced cookies that were slightly taller in height and decreased in spread compared to Control, but the differences were insignificant. Cookies made without eggs or egg replacers spread slightly more than Control in the oven, but the differences were minimal and were rated acceptable. This suggests that the egg replacers provided some binding functionality in the dough, which produced an appropriate amount of spread and rise in all the Test cookies.

Cooked Appearance & Color

Appearance scores were similar across the cookies, with almost all cookies having higher scores on Day 1 than on Day 21. By the end of testing, all samples exhibited some slight crumbling on the edges, resulting in a dusty appearance.

The appearance of Control was rated the most appealing sample on Day 1, as ‘moderately appealing.’ It decreased in appeal over time. Control was rated the darkest sample in sensory evaluation. One panelist commented it was “nicely browned,” while others thought it looked over baked. Colorimeter results showed that Control was fairly yellow compared to the other samples.

Two egg replacers tied with Control for the highest average appearance score, but were both rated lighter in color by panelists. Negative Control had fairly high appearance scores and was the least yellow sample in analytical testing. However panelists thought the exterior looked appropriately golden brown, but more flat and “sunken in the center.” Panelists considered most of the Tests neither appealing nor unappealing in appearance.

EATING QUALITY

Cooked Aroma

Cooked aroma intensity did not change significantly over time in most of the samples, including Control, and average scores ranged from ‘neither faint nor strong’ to ‘slightly strong.’ Cooked aroma likeability also did not change significantly over time.

Control was the most highly rated sample in aroma intensity and likability, with a ‘slightly strong’ average aroma score and ‘very appealing’ aroma intensity that was described as “delicious!” and smelling of “chocolate, vanilla, caramel notes” and “fresh baked, classic chocolate chip cookie aroma.”

After Control, Negative Control was found to have the most appealing aroma. Without eggs, panelists found Negative Control to be missing “baked, brown notes,” but noted that it smelled “strongly of chocolate” and artificial butter or margarine. This was a common trait shared among many of the egg replacers. Another common aroma attribute of the egg replacer Tests were notes of “undercooked flour” and over time, that the cookies smelled stale. The results imply that in formulas with reduced egg content, overall aroma is slightly weakened and is slightly less appealing.

Moisture

The moisture content changed over the course of testing in all the samples, with the widest range of moisture values among samples occurring on the first day of testing, and the values becoming more similar over time.

On Day 1, Negative Control had the highest moisture content, followed by Control. Most of the egg replacer Tests were fairly similar to each other. On Day 14, Negative Control had dropped in moisture by more than half, and Control by a third. Nearly all the egg replacer Tests varied only slightly from their Day 1 values and each other. By Day 21, both Negative Control and Control increased in moisture slightly, as did many of the egg replacer Tests. However, the moisture content fluctuations among the samples did not have a significant effect on eating quality.

Water Activity

Control and Negative Control had the highest water activity, but were still in the appropriate target range



for cookies. All egg replacer Tests were slightly lower in A_w compared to Control, but were within an acceptable range.

Texture

All of the cookie samples were relatively tender; no samples were rated higher than 'moderately hard/tough.' Over the course of 21 days, the structure of all cookie samples became tenderer and almost all became crunchier as they dried out, but the changes were slight.

There was no significant change in sensory or analytical texture tests of Control over time, including structure, mouthfeel, hardness, brittleness, or work to break. In sensory analysis, the structure of Control on Day 1 was rated 'slightly hard/tough,' and was downgraded only slightly by Day 21 to 'neither friable/tender nor hard/tough.' These scores correlate with the texture analysis results for hardness and work to break, both of which fluctuated, but ultimately decreased over time. This indicated that the cookie became slightly more tender and easier to break. The perceived mouthfeel of Control did not change very much over time, according to sensory analysis scores. Textural comments included "crunchy snap as expected for a crispy chocolate chip cookie."

Many Tests were similar in structure to Control on Day 1, rated as 'neither friable/tender nor hard/tough,' including Negative Control.

Flavor

Flavor intensity varied slightly among samples throughout testing, but ultimately decreased for all samples over the course of 21 days. Control did not significantly change over time.

Control was the highest rated sample for flavor likability on Days 1 and 14, and was described as tasting, "as expected, good cookie flavor" and scoring the highest of all the Tests. By day 21, Control had started to taste somewhat stale to panelists and was downgraded to 'neither unappealing nor appealing flavor,' and Negative Control (which stayed relatively static throughout testing) surpassed Control to become the highest rated sample in flavor likability. Negative Control was rated most closely to Control throughout testing, but panelists did comment that Negative Control tasted slightly oily, like "artificial butter" and even "fried-tasting" on all test days.

Overall Likability

In overall likability, Control had the highest average score over the course of testing. On Day 1 it was rated 'very appealing,' but was downgraded to 'neither appealing nor unappealing' on Day 21. On the first day of testing, panelists wrote, "this is a quality cookie," and commented it had "really nice flavor and texture, yummy," but that it was "hard and somewhat tough." By the end of testing, panelists observed that it was "pretty hard, less crunchy, and slightly stale. Not great."

Most of the egg replacer samples followed a similar pattern of deterioration over time, as the textures became tenderer and off-putting flavors emerged. However, Negative Control remained relatively stable over time, and ultimately was the Test most closely rated to Control in overall likability. Panelists remarked that it was "noticeably artificial tasting," but it was "pleasant to eat" and "very crunchy." Most of the Tests had very similar average overall likability scores, indicating that egg replacers did not positively affect overall chocolate chip cookie quality.

CONCLUSIONS

The use of ingredients to successfully reduce or replace eggs in chocolate chip cookies can be challenging for even the most accomplished baker. The sensory evaluation results from panelists on the organoleptic attributes of the chocolate chip cookies were generally consistent with the findings of the objective analytical test results. The areas of chocolate chip cookie quality most negatively affected when eggs are removed and/or replaced, included aroma, flavor, texture, and to a lesser extent, color and appearance.

Tasters unanimously preferred the Control to the Test formulas on Days 1 and 14 of testing, but it was downgraded slightly over time for a stale flavor. Its appealingly high rise, round edges, crispy, snappy texture and sweet, classic chocolate chip cookie aroma and flavor won panelists' approval as the most appealing cookie. It was neither dry nor moist, and its structure was firm in the mouth, yet crunchy and pleasant to eat. It did become slightly less hard over time in texture analysis, as it became stale.



The chocolate chip cookie formula made without eggs, Negative Control, performed better than egg replacers in almost all of the tests, especially in aroma, flavor and texture. It had the most noticeably different shape than Control, being thinner in height and wider in diameter, although panelists still rated its appearance highly. The aroma of Negative Control was slightly less strong than that of Control, it was rated as more appealing than the egg replacer Tests. While the Negative Control had generally favorable flavor likability scores, it was noticeably oilier than Control, indicating that eggs contribute to a balanced, characteristic sweet baked good flavor in chocolate chip cookies. Overall, it was the next most highly rated cookie after Control in overall likability, indicating that chocolate chip cookies may be better off without egg replacers than with them.

Egg replacer performance varied both in analytical tests and sensory evaluation. The egg replacer that performed best was one of the starch-based products. It produced cookies with slightly lighter color than Control but that looked very similar in shape and spread. The aroma was more chocolate-forward, and increased in intensity and decreased in likability over time. Panelists thought the texture was slightly dry, but nicely crisp, and the texture was appropriately hard and brittle, according to texture analysis results. Overall, cookies made with this product were neither particularly appealing nor unappealing to panelists.

Another egg replacer that was rated neutral in overall likability was the algae product. It produced cookies with slightly lower rise and increased spread than that of Control, but these differences were not particularly apparent to panelists. However, panelists did notice the overly yellow color of the cookies and thought some of the cookies looked unevenly baked. Of all the samples, these were the softest, most brittle, and took the least amount of work to break. These results indicate that cookies made with this egg replacer product lack proper structure and may be prone to breakage during packaging and/or shipping, an undesirable attribute in crisp chocolate chip cookies. Besides color and texture, these cookies also had slightly off, beany and vegetal flavors, resulting in neutral overall likability scores.

The egg replacer that performed most poorly in chocolate chip cookie tests was one of the blended ingredient products. It produced samples similar in darkness to Control, but was slightly less golden brown in hue. It was rated as having strong aroma intensity and likability, smelling of caramel and chocolate. Texturally, it scored in the middle, being appropriately hard, brittle and crispy. However, panelists picked up noticeably off-putting flavors in the cookies, which tasted eggy, beany, dusty, artificial and rancid. Overall, panelists found these cookies moderately unappealing.

Egg replacer products that performed neither particularly good nor bad, included soy, whey protein concentrate, wheat and the other blended product. Unfortunately, few generalizations about egg replacers can be made, because they vary vastly from supplier to supplier, as evidenced by the difference in results between the two starch and blended ingredient egg replacers. Even though ingredient manufacturers may have usage rate recommendations and even starting formulations, many manufacturers 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 chocolate chip cookies 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 chocolate chip cookie formulations.

COMPLETE RESEARCH REPORT & FINDINGS

For a copy of the complete 57-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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