Red Star Nutritional Yeast as a Substitute for Cheddar Cheese in Mac and Cheese Dish

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Abstract

The objective of this experiment was to find out if nutritional yeast flakes were an acceptable replacement for cheddar cheese in order to reduce saturated fat content, reduce cholesterol, and increase vitamin B_{12} intake in individuals trying to reduce their animal consumption. The control recipe used in this experiment was a basic macaroni and cheese dish. One variation of the control recipe used nutritional yeast to replace half the amount of cheddar cheese, and another variation used it to replace all of the cheddar cheese. These three recipes were all blindly tested amongst 30 participants for overall eating quality, texture, and flavor. Participants closely favored the control recipe and the 50% nutritional yeast variation by a difference of 0.3 in the overall eating quality; however, the participants did report stronger flavors and thicker texture in both the nutritional yeast recipes in comparison to the control recipe. Nutritional yeast flakes have a unique flavor and has the potential to be used as an acceptable alternative to replace high saturated fat cheeses as evidenced by participants conducted in this study.

Introduction

Cheese is a healthy source of calcium, protein, and other vitamins and minerals, but at the same time, it contributes high amounts of fat and sodium to one's diet. Fat and salt play an important role in the flavor, texture, and mouth feel of cheese. While we do need some amounts of salt and fat to function properly, a diet low in sodium and fat, saturated fat in particular, is recommended. A diet high in saturated fats, such as cheese, and trans fats, can lead to high levels of cholesterol in the blood. Excessive sodium, fat and cholesterol consumption are linked to diseases such as coronary heart disease, high blood pressure, and obesity.

However, when fat is removed from cheese, or other products, it loses flavor, texture and other desirable eating qualities. Nutritional yeast is a supplement that has a somewhat cheesy flavor to it. It is a great source of B_{12} vitamins and is also low in fat and sodium. These desirable nutritional qualities, along with its flavor, would make nutritional yeast an acceptable cheese substitute.

Literature Review

As rates of nutritional diseases, such as obesity, cardiovascular disease, and hypertension, rise, the promotion of low fat and low sodium foods have also increased. According to the 2010 Dietary Guidelines for Americans, it is recommended that adults 19 years and older receive 20–35% of their calories from fat, and less than 10% of calories come from saturated fat ("Dietary guidelines for," 2010). Saturated fats are solid at room temperature and mainly come from animal products. Some plant oils contain saturated fat, such as coconut and palm oils. “Diets high in saturated fat have been linked to chronic disease, specifically, coronary heart disease” (Centers for Disease Control and Prevention, 2012). The World Health Organization (WHO) conveys the leading causes of death are heart related issues such as ischemic heart disease and stroke. (WHO, 2011). Since saturated fats are associated with heart disease and other health problems, it is recommended to reduce the intake of these fats and to replace them with unsaturated ones. “If an individual drinking the recommended three cups of milk a day switched from whole milk to 1% milk, they would reduce their saturated fat intake by 3,311 grams and their calories by almost 47,000 a year” (Maddock, 2007, p. 954). Simple substitutions to low fat dairy products can have significantly lower the amount of saturated fat in a person’s diet, and reduce calorie intake. In the American diet, a major source of saturated

fat is cheese ("Dietary guidelines for," 2010). Consuming less cheese could lower saturated fat intake.

In addition to fat, cheese also contributes a significant amount of sodium to one's diet. The adequate intake level of sodium for adults is 1,500 mg a day, but Americans consume an estimated 3,400 mg of sodium each day ("Dietary guidelines for," 2010). The American diet is notorious for being extremely high in sodium. "Diets with high amounts of sodium cause retention of water in the body, which may originate or accentuate hypertension, an important risk factor for the development of cardiovascular diseases" (Cruz, 2011, p. 277). The relationship between sodium and heart health is well known and "heart healthy" products have been used as a marketing strategy for many food companies. A popular contributor of salt is processed, fast food. But, even frequent consumption of foods that have less sodium can also add up. These foods can include, certain types of meat, such as salami and bacon, breads and pastries, and canned foods. **"**In the American diet, dairy products contribute to approximately 11% of the total sodium intake…" (Cruz, 2011, p. 277). Reducing consumption of dairy products, specifically cheese, can lower sodium intake, and therefore lowering the risk hypertension and heart disease.

Nutritional yeast is an inactive yeast derived from a single-celled organism referred to as Saccharomyces Cerevisiae (Donaldson, M. 2000). Nutritional yeast has a flavor that is described as cheesy, nutty, savory and umami. It can be used to thicken, stabilize food, enhance flavor, and increase nutritional value of recipes. According to Red Star, nutritional yeast contains B-vitamins, folic acid, glutamic acid, selenium, zinc, and protein. In just two tablespoons of Red Star nutritional yeast there is 7 grams of dietary

fiber, which is also linked to cardiovascular health. Additionally, nutritional yeast is also low in fat and sodium. Nutritional yeast is fortified with vitamin B_{12}, also known as cobalamin. Cobalamin is water-soluble and plays essential roles in brain function, nervous system, blood formation, and metabolism. Vitamin B_{12} is found exclusively in animal products and thus has no cholesterol. It is important for individuals who are not consuming animal products to receive absorbable forms of B_{12} either from fortified foods, or from supplements such as nutritional yeast (Webb, D. 2000).

Methods and Design

For this experiment we chose to prepare a macaroni and cheese recipe, in which the independent variable was cheese. The recipe we chose used two types of cheeses, cheddar, and Parmesan. We chose to use the cheddar cheese as our independent variable as it was used in greater amounts than the Parmesan. Our control recipe used 100% of the cheddar cheese the recipe called for, whereas our two experimental batches incorporated nutritional yeast into the recipe. One experimental variation replaced half of the cheddar with nutritional yeast, and the second variation replaced all of the cheddar cheese. Several trial runs were prepared before the final public tasting.

First, a standardized recipe was retrieved from a popular recipe with high ratings from allrecipes.com (see Appendix B). An initial trial run of the control recipe was conducted in order to test for any possible errors and the over all final product. During this first run, we found that since the ingredients were listed in standard household measurements, it main be difficult to maintain accuracy, so the measurements were converted into weights. We also found that the pasta was too soft when cooked according to the recipe. We reduced the amount of time the pasta was boiled from 8 minutes, to 3

minutes. Next we divided the recipe by three in order to prepare all three variations using one recipe batch. All three recipes were allowed to cool for 10 minutes before tasting.

Several trial runs of each variation were made in order to evaluate the samples' sensory and objective characteristics. During these trial runs sensory information about the food's flavor, texture, appearance, and overall preferred sample were noted (see Appendix A). Two objective tests were conducted to test the effect of replacing cheddar cheese with nutritional yeast. The objective qualities we chose to measure were the viscosity of the cheese sauce, and the changes in moisture content of the final product.

A line spread test was used to measure the viscosity of the three different macaroni and cheese sauces. According to McWilliams, a line spread test uses a template of measured concentric circles divided into four 90° increments. Using a ring the same diameter as the inner most circle on the template, a predetermined amount of ¼ cup sauce was poured into the ring placed over the smallest circle. The ring was evenly lifted up, so that the sauce can spread out evenly from the center. The sauce was allowed to spread for 1 minute before measurements were taken. Measurements were taken at each of the template's 90° increments and the average of these measurements were calculated to find the line spread value. The line spread test was done three times and the average of the three trials was recorded for each sauce (see Appendix A). Each test was conducted with each of the sauces at 120° Fahrenheit to limit the effect temperature has on viscosity. For some foods, the colder they are, the more viscous and slow moving they get. Having each sauce at the same temperature controls for this factor.

During our trial runs, we noticed that there were significant differences in the consistency of each sauce. The second objective test we chose to use an oven to

determine if nutritional yeast had an effect on the moisture content of each sample. To perform a drying oven test, the weight of the original sample is needed before drying. "Then the food is dried until the dried weight remains constant" (McWilliams, 2012). Prior to beginning this test, the baking dishes we were using were weighed alone before the ingredients were added. The weight of the dishes was subtracted from the pre-baking weight and from the post-baking weights, after the products had time to cool after ten minutes. This allowed us to measure just the weight of the food. The moisture content of each variation was calculated using the following equation: (Initial-dried weight/initial weight) X 100= % moisture.

Results

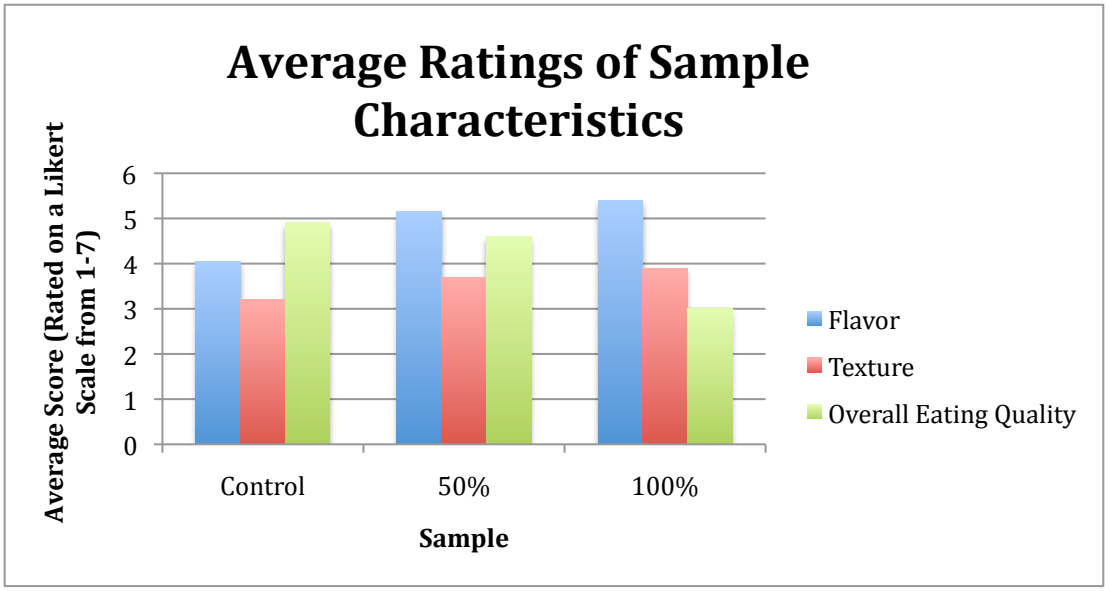

Figure 1 The Average Ratings of Sample Characteristics. A compilation of the average Likert scores for flavor, texture, and overall eating quality, n=30.

As the amount of nutritional yeast in the samples increased, the stronger the overall flavor became compared to the control sample. Also, as the amount of nutritional yeast in the samples increased, the grittier the texture became. However, overall eating

quality decreased as the amount of nutritional yeast increased.

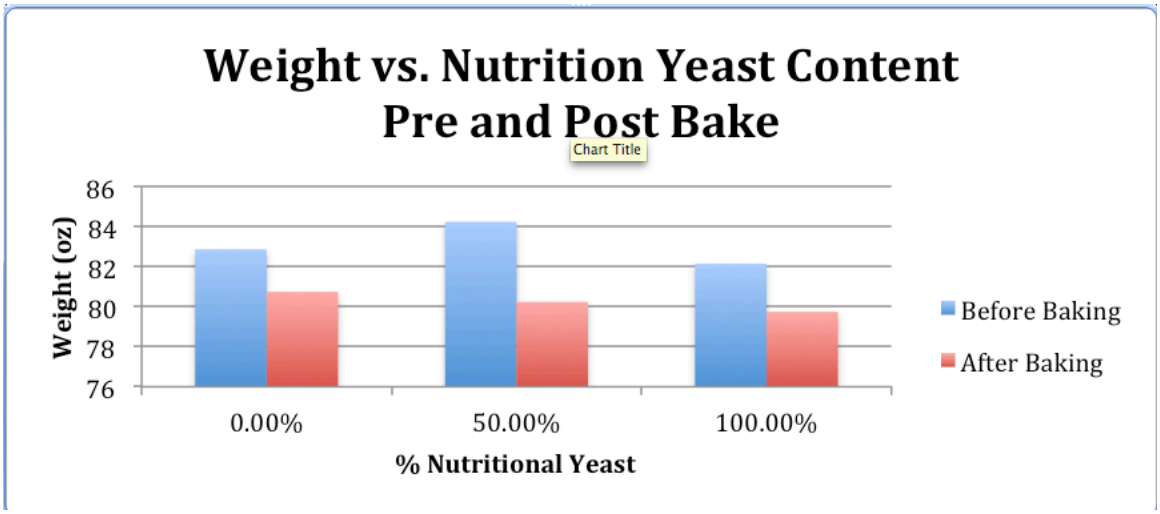

Figure 2. Shows differences of weight for the three macaroni and cheese variations before and ten minutes after baking.

The controlled recipe weighed slightly more before baking than the 100% nutritional yeast variation. Interestingly, however, the 50% variation using half cheese and half yeast weighed the most out of all three variations.

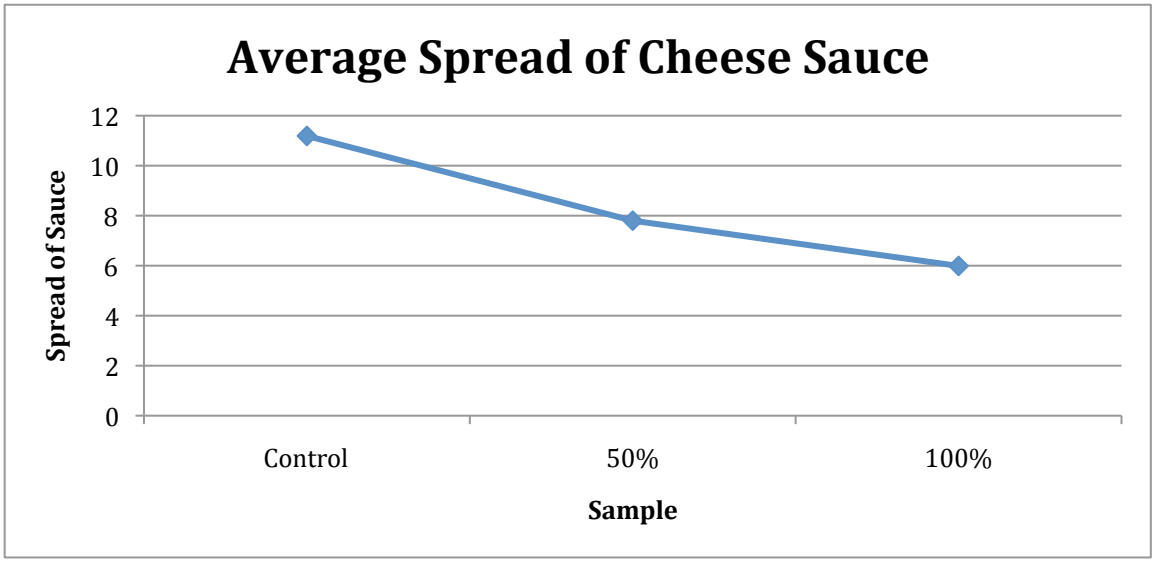

Figure 3. Shows the correlation between the spread ability of each sauce and the amount of nutritional yeast used.

As the amount of nutritional yeast increased, the average viscosity of the cheese sauce for the macaroni decreased. The viscosity of the 100% nutritional yeast variation was only half that of the control recipe.

Discussion

In order to measure the flavor, texture, and overall eating quality of our samples, a blind, public tasting was organized. During this tasting, 30 people ranked these qualities on a Likert scale of 1-7. The average ratings of the characteristics of the samples are shown in Figure 1. On average the Control sample had the lowest rating for flavor with a score of 4.05, the 50% and the 100% samples had the highest ratings of 5.15 and 5.4 respectively. The control sample had the lowest texture rating, which meant it was the smoothest, with an average of 3.2. The 50% sample had an average texture rating of 3.7, and the 100% sample had the grittiest texture with an average of 3.9. The control sample had the highest overall eating quality, with a score of 4.9, and the 50% sample followed closely with as score of 4.6. The 100% sample had the lowest overall eating quality with an average Likert score of 3.

Our objective test for moisture content did not show a clear relationship between weight reduction and the percent of nutritional yeast being used in the pasta. This could be due to our small sample size of only three batches and perhaps we would see a more definitive relationship if more batches with different levels of nutritional yeast being substituted were prepared and analyzed. As depicted in Figure 2, the control batch, which had no nutritional yeast, there was a 2.6% weight reduction. For the batch that had a 50/50 split between the sharp cheddar cheese and nutritional yeast there was a 4.7% reduction. For the final batch that was 100% nutritional yeast and no cheddar cheese,

there we had a 2.9% reduction. The weight reduction was greatest in the 50% nutritional yeast variation, which went against our initial hypothesis for this objective test (see appendix for further detail).

The line-spread test, shown in Figure 3, analyzed the effect that nutritional yeast has on another physical trait of the pasta sauce: viscosity. This time, as Figure 3 shows, there is a significant relationship between the viscosity of the sauce and the amount of nutritional yeast used. The control was the least viscous in that it spread the furthest to an average of 11.12. The flow of each sauce decreased when more nutritional yeast was used. The 50% variation spread out to an average 7.8, and the 100% variation was the thickest and had an average spread of only 5.99. This is what was expected simply because of the dry flake form of the nutritional yeast. When compared to the texture of most cheeses, nutritional yeast is much drier, so it is no surprise why spread ability decreased using more nutritional yeast.

Conclusion

The hypothesis of this experiment was to test if nutritional yeast would be an acceptable replacement for cheddar cheese in a macaroni and cheese recipe. Results indicate that nutritional yeast would be an acceptable replacement for at least of the cheese in the recipe. Although nutritional yeast was not found to be an acceptable replacement amount for all of the cheddar, even a half and half substitution can have positive health benefits. Incorporating nutritional yeast into one's diet either as a replacement for cheese, or in general, can reduce the amount of dietary fat one consumes, and add a significant amount of vitamin B_{12}.

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Appendix A

Individual Experiment notes:

We decided on a standard macaroni and cheese recipe to use to conduct our research project with nutritional yeast as a cheese substitution. Substituting nutritional yeast for cheddar cheese is conducted to test the difference in taste, appearance, texture, or likability. Since nutritional yeast is not derived from an animal it lacks cholesterol, it is an excellent source of fortified vitamin B-12, it contains no salt, and it is low in fat. Cheddar cheese is a good source of calcium and other nutrients, but it is high in saturated fat, salt, and cholesterol. It was our mistake in thinking that the recipe would taste fine. However, when we tested out the recipe for our control sample it was not a satisfying macaroni and cheese. We came to the conclusion that a human error must have occurred and nothing was wrong with the recipe. This recipe was used with the 3 cups milk as indicated in the recipe. The milk that was provided in the lab was 2% milk, which generated limitations with a lactose sensitivity. The instructor was notified and almond milk was used in replace of the 2% milk after making the first 2 trials with the 2% milk.

Trail 1.

This is the first day the standardized recipe was fabricated for this research study. This run through was conducted within the lab kitchen.

Purpose: To test objective and sensory evaluations of the standardized recipe for the first time. The control recipe contains cheddar cheese as the base of the macaroni and cheese sauce, which will be evaluated by the overall acceptability, texture, appearance, and flavor.

Methods:

1. All the ingredients were collected and measured and the oven was preheated to 350 degrees F top and bottom baking.
2. In a large 6 quart pan 10 cups of water was brought to a rolling boil in 16 minutes with the lid on. 2 cups of dry elbow macaroni (8 ounces) was added to the boiling water and stirred gently. Covered with lid to bring to a boil again faster on high temperature, which took 8 minutes. The pasta was put into a strainer over the sink to run cold water on top of it to prevent further cooking then it was transferred to a buttered casserole dish to prevent product from sticking to the dish.
3. In a sauce pan, ¼ cup of butter was melted over medium heat. After the butter was melted completely unsifted flour was slowly added to the sauce to create a roux. Then the 2 % milk was added slowly and stirred constantly. The parmesan and 1 cup of cheddar cheese was added to melt into the roux to create a thickened sauce.
4. In another sauce pan butter was melted completely and breadcrumbs were added to toast.
5. The cheese sauce was mixed in on top of the elbow macaroni pasta and covered with breadcrumbs then ¼ tsp paprika was sprinkled on top.
6. The casserole was put into the preheated oven at 350 degrees F for 30 minutes.

7. After the casserole was completely baked, it was cooled for about 10 minutes before we tried the finished product.

Sensory evaluations were performed on this controlled product where we had a panel of tasters evaluate the color, flavor and tenderness of the control recipe. The data below was collected on the evaluations.

Control Sample: Trial 1. (likability scale 1-7, 1= dislike, 7= very much liked)

	Likability Rating	Comments
Color	6, 6, 7, 6, 7	White with slight yellow hue
Flavor	2, 4, 5, 3, 3	Very bland, but very creamy, needs more paprika etc
Texture	3, 4, 2, 2, 1	Pasta is over cooked, too mushy, very saucy

Mean of Control Sample Trail 1. Sensory Evaluation:

	Color	Flavor	Texture
Mean	5.2	3.4	2.4

Discussion:
The color of the control sample was acceptable and liked. The flavor was lacking a bit and needs more pepper, and paprika to meet the tasters preferred liking. The texture on the other hand was poor due to the pasta being over cooked. Notes for future trial: to prevent the mushy, poor texture leave pasta uncovered while cooking and cook until pasta is al dente.

Trial 2.

Purpose: To improve the overall sensory evaluations of the control recipe. Trial 1 flavor was bland and texture was mushy.

Methods:

1. All dry ingredients were collected first and measured then the wet ingredients were collected and measured. Oven was preheated to 350 degrees F
2. In a large 6 quart pan 10 cups of water was brought to a rolling boil in 16 minutes with the lid on. 2 cups of dry elbow macaroni (8 ounces) was added to the boiling water and stirred gently. The lid was not used to cover the macaroni. The pasta was cooked for 5 minutes total (instead of the 8 minutes from trial 1) and was very al dente.
3. The pasta was put into a strainer over the sink to run cold water on top of it to stop the cooking then it was transferred to an unbuttered dish to eliminate excessive moisture that could contribute to the mushy texture from trial 1.
4. On the stove, in a small sauce pan ¼ cup of butter was melted over medium heat. After the butter was melted completely, unsifted flour was slowly added to the sauce to create a roux about 1.5 tablespoons. Then the 2 % milk was added slowly

and stirred constantly. The parmesan and 1 cup of cheddar cheese was added to melt into the roux to create a thickened sauce.
5. In another sauce pan butter was melted completely and breadcrumbs were added to toast.
6. The cheese sauce was mixed in on top of the elbow macaroni pasta and covered with breadcrumbs then ¼ tsp paprika was sprinkled on top.
7. The casserole was put into the preheated oven at 350 degrees F for 30 minutes.
8. After the casserole was completely baked, it was cooled for about 10 minutes.

Evaluation notes:
Trial 2 was fabricated outside of lab. Things that were changed from trial 1 and trial 2 were cooking to pasta without the lid, putting the pasta in an unbuttered casserole dish, more unsifted flour was added to the sauce to make sauce less saucy. When using cheese in an ingredient in recipes it adds flavor and texture. In most cases we want the cheese to melt and mix evenly. During trial 2 the sauce was difficult to melt and it clumped possibly due to adding the flour in too fast, but the sauce began to even out and be smooth again. Since Cheddar cheese is in the medium moisture content it is expected to clump in sauces until it reaches its melting point of 150 F (McGee, 2004). The texture of the pasta was very likable and it was decided that we use this cook time of 5 minutes throughout the future trials.

Trial 3.

A limitation arose during previous trials due to a lactose sensitivity and we decided to alter the recipe with almond milk in replace of the 2% cows milk. We completely displaced cheddar cheese for nutritional yeast and another sample in the replacement of cheddar cheese. For another sample we tested the displacing half of the cheddar cheese with nutritional yeast.

Purpose: To test if the replacement of 2% cows milk to almond milk will alter the texture, flavor, color, appearance, or acceptability of the samples. To generate a run through with an extreme modification and determine what was an acceptable variation for this research.

Methods:
1. All dry ingredients were collected first for all three samples and measured with a kitchen scale then the wet ingredients were collected for all three samples and measured with a kitchen scale. Oven was preheated to 350 degrees F.
2. In 3 separate pans 8 cups of water was brought to a rolling boil in each. 5 oz of elbow macaroni was added to the boiling water and stirred gently in each pan. The pasta was cooked for 5 minutes each.
3. The pasta was transferred into 3 individual strainers over the sink to run cold water on top of them to stop the cooking then they were each transferred to an unbuttered casserole dish and set aside.
4. In 3 separate sauce pans, 2 Tbsp are melted over medium heat. After the butter was melted completely, unsifted flour was slowly added to the sauce to create a roux 2.5 tablespoons. Then 1.5 cups almond milk was added slowly and stirred

constantly to all sauce pans. The ¼ cup parmesan is added to all sauces and dissolved.

5. In one sauce pan 1 cup of cheddar cheese was added to melt into the roux to create a thickened sauce.
6. In the 2nd sauce pan ½ cup cheddar cheese and ½ cup nutritional yeast is added and dissolved into the roux.
7. In the 3rd sauce pan 1 cup nutritional yeast was added to the roux.
8. Each sauce was poured into its own casserole dish with the cooked macaroni and mixed.
9. Each sample was placed into the preheated oven for 30 minutes.

Control	Likability Rating	Comments
Color	6, 5, 7	White with slight yellow hue
Flavor	2, 1, 5	Somewhat boring, but very creamy
Texture	6, 5, 3	Good, but a bit greasy, very tender

50%	Likability Rating	Comments
Color	7, 7, 7,	Very mustard yellowish
Flavor	7, 7,7	Great nutty, creamy ratio
Texture	7,7,7	Great texture

100%	Likability Rating	Comments
Color	4, 5, 4	Has a very mustard greenish tint to it
Flavor	6, 6, 4	Has a very nutty buttery taste
Texture	6, 6, 5	A bit gummy but still good

Discussion:
In trial 3 the recipe serving size was reduced and the generated modifications were acceptable. These modifications used for each sample will be the proportions used in the future trials and for this research study.

Trial 4.

In Trial 4, only the sauce of each sample was prepared and objectively tested for spreadibility.

Purpose: To objectively test the moisture content of each cheese sauce by measuring its spreadibility conducted with the line spread sheet.

Methods:

1. All dry ingredients were collected first for all three samples and measured with a kitchen scale then the wet ingredients were collected for all three samples and measured with a kitchen scale.
2. In 3 separate sauce pans, 2 Tbsp are melted over medium heat. After the butter was melted completely, unsifted flour was slowly added to the sauce to create a roux 2.5 tablespoons. Then 1.5 cups almond milk was added slowly and stirred

constantly to all sauce pans. The ¼ cup parmesan is added to all sauces and dissolved.

3. In one sauce pan 1 cup of cheddar cheese was added to melt into the roux to create a thickened sauce.
4. In the 2nd sauce pan ½ cup cheddar cheese and ½ cup nutritional yeast is added and dissolved into the roux.
5. In the 3rd sauce pan 1 cup nutritional yeast was added to the roux.
6. ¼ cup was collected from sample 1 the control and was tested with the line spread test. It was timed for 1:00 minute and measured how far it spread on the line sheet. This was repeated another 2 times with this same sample.
7. ¼ cup was collected from sample 2 the 50% nutritional yeast and was measured on the line spread sheet for 1:00 minute. This was repeated another 2 times with this same sample.
8. ¼ cup was collected from sample 3 the 100% nutritional yeast and was measured on the line spread sheet for 1:00 minute. This was repeated another 2 times with this same sample.

Line Spread Test

Control					Mean
Trial 1	10	11	13.5	12	11.6
Trail 2	10	10	12.5	12	11.1
Trail 3	9	10	12.5	12	10.87
				Total Ave =	11.19

50%					Mean
Trial 1	10	9.5	8	6.5	8.5
Trail 2	7	7.5	9	8	7.9
Trail 3	6	7	8	7	7.0
				Total Ave =	7.8

100%					Mean
Trail 1	6.5	6	8	6	6.6
Trail 2	5	5.5	6	7	5.87
Trail 3	5	6	5.5	5.5	5.5
				Total Ave =	5.99

Evaluation notes:
The sauces were difficult to keep at the same temperatures throughout this procedure but we constantly tested the temperatures to keep them close. A significant relationship between the spreadability of the sauce and the amount of nutritional yeast used is revealed. The spreadability decreases with increased nutritional yeast usage and this is what was expected simply because of the dry flake form of the nutritional yeast. When compared to the texture of most cheeses, nutritional yeast is much drier so it is no surprise why spreadability decreased using more nutritional yeast.

Trial 5.

Purpose: To objectively test the moisture content of each sample this time using the drying oven physical method by collecting the weight of each sample's pre and post baking weight.

Methods:

1. All dry ingredients were collected first and measured with a kitchen scale and set aside then the wet ingredients were collected and measured with a kitchen scale. Oven was preheated to 350 degrees F.
2. The samples were all exactly like trial 3 except the casserole dishes were weighed alone with a kitchen scale.
3. Each sample was weighed on the kitchen scale and the casserole dish weight was subtracted.
4. Then the samples were placed into the pre-heated oven

Oven-drying test for moisture:

Sample	Weight Before baking (oz)	Weight After baking: (oz)
Control	82.87	80.75
50 %	84.25	80.25
100 %	82.25	79.75

Evaluation notes:
During the pre and post baking objective test for moisture we hypothesized that the weight reduction will be greatest in the 100% nutritional yeast, which contributes to the visual appearance of the final product. The 100% nutritional yeast product is gummy, dry, and seemed to have less moisture content compared to the other variables. The lower fat and absence of sugar within the extreme 100% nutritional yeast variable could have played a role in the weight reduction. Recipes with more fat are more likely to stay moist and tender. Unfortunately, there seems to be no clear relationship between weight reduction and the percent of nutritional yeast being used in the pasta. This could be due to our small sample size of only three batches and perhaps we would see a more definitive relationship if more batches with different levels of nutritional yeast being substituted were prepared and analyzed. For the control batch, which had no nutrition yeast, there was a 2.6% weight reduction. For the batch that had a 50/50 split between the sharp cheddar cheese and nutritional yeast there was a 4.7% reduction. For the final batch that was 100% nutritional yeast and no cheddar cheese, there we had a 2.9% reduction. The weight reduction is greatest in the 50% nutritional yeast variation, which went against our hypothesis.

Trial 6.

Trial 6 was conducted because the scheduled blind test did not allow time for us to prepare our samples that same day. The only solution was to prepare the samples the

night before hand. The samples would need proper cold holding storage and reheating properly for food service.

Purpose: To evaluate the effect of refrigeration storage and reheating each sample.

Methods:

1. The samples were prepared the same as trial 3.
2. The samples were cooled for 1.5 and put into the refrigerator over night. To cool our macaroni and cheese from 165 degrees F properly we used a instant-read thermometer to watch for the target temperature of about 95 degrees F within a two hour period, so the samples could be then put in refrigeration at 40 F.
3. The samples were taken out the next day covered with tin foil were removed from the cold storage and reheated in a preheated oven of 350 F for 10 minutes.
4. The samples were checked for proper temperatures and they were not hot enough so they were placed back into the oven for another 10 minutes.
5. Using the instant-read thermometer each sample was checked and had met the 165 degrees for reheating safety.

The sample were then served and evaluated amongst our acceptability.

Discussion:
Chilling and reheating foods safely requires strict attention to timing and temperatures. We were worried about the effect of repeated heating and cooling on the flavor and texture of our samples. The overall eating quality is good but it is not great. It definitely tastes better when you have it come straight from the oven. It would have been interesting to have a blind tasting of 6 samples total with 3 of the samples being left overs and the other 3 coming straight from the oven.

Trial 7.

The macaroni and cheese samples were prepared the night before with the exact same methods as trial 6, but the reheating time and temperatures were already figured out after trial 6, which were used in trial 7. These samples were reheated in the lab ovens individually.

Purpose: To collect a final blind sensory test evaluation from a panel.

Methods:

1. Each sample was prepared and cooled the same as trial 6.
2. The samples were transported to the lab kitchen and put into cold storage (10 minute time lapse).
3. Plates were divided into 3 portions marked with corresponding numbers
   389 = control sample
   556 = 50 % nutritional yeast
   270 = 100% nutritional yeast

4. Scorecards were given and explained to the panel participants without revealing the product substitution or any other information that may alter their evaluations. Possible allergenic ingredients were revealed such as the use of almond milk and dairy.
5. Each sample was reheated separately in the lab ovens at 350 degrees F for 20 minutes.
6. Each sample was place on the correct section of the plate and the participants blindly evaluated each sample.

Raw Data of Score Cards

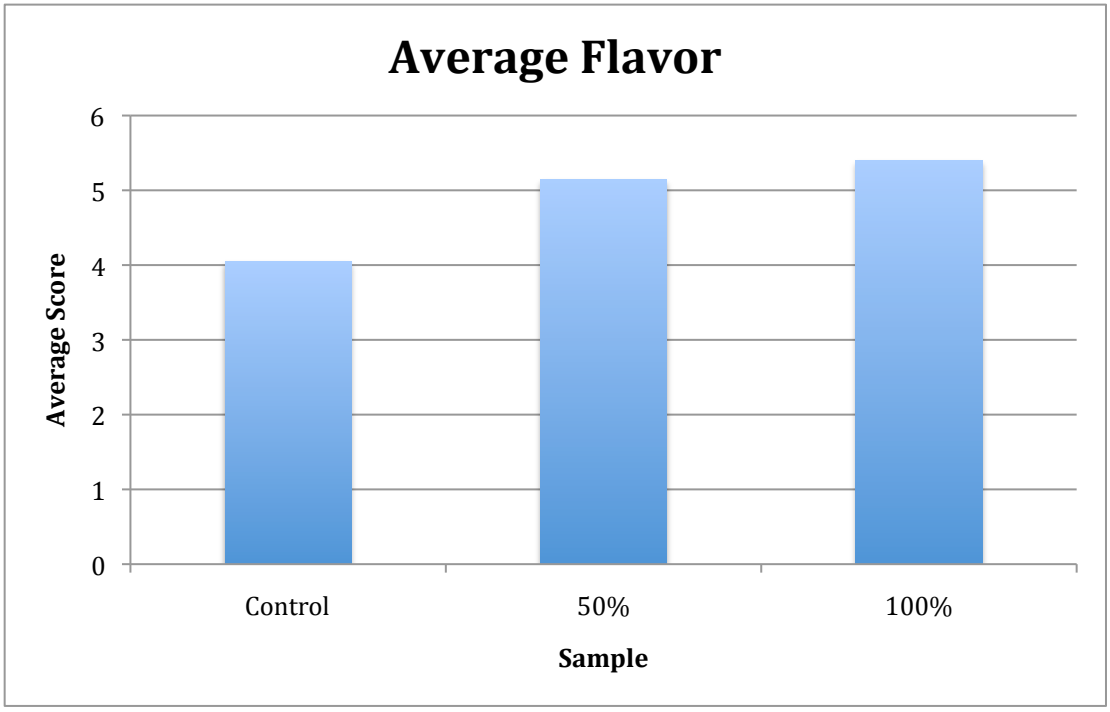
Flavor			
	Control	50%	100%
	2	7	5
	2	5	3
	5	6	7
	2	4	6
	2	4	5
	6	5	5
	5	5	7
	3	5	6
	6	7	7
	4	1	3
	7	1	6
	2	5	7
	3	5	2
	3	4	5
	4	5	4
	1	4	4
	6	7	7
	6	5	6
	2	7	7
	4	7	6
	6	5	3
	5	3	6
	5	6	3
	3	7	5
	5.5	5.5	6
	3	4	5
	4	5	6
	6	7	7
	5	7	6
	4	6	7
Total Average	4.05	5.15	5.4
Texture			

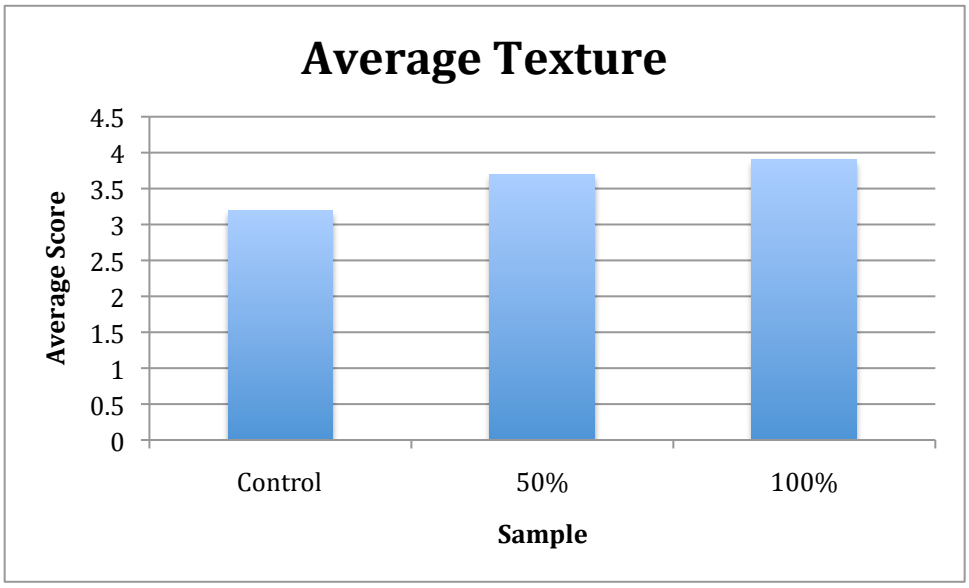
	Control	50%	100%
	4	5	1
	1	5	7
	4	3	3
	3	4	5
	6	2	2
	6	2	1
	4	4	3
	1	2	3
	3	3	3
	3	3	2
	6	7	7
	2	5	6
	3	5	6
	2	4	4
	5	5	4
	5	5	7
	2	4	5
	2	4	5
	5	5	5
	1	4	4
	1	3	3
	2	5	4
	2	4	3
	2	3	4
	2	5	6
	2	3	3
	4	4	6
	5	1	1
	3	1	2
	4	2	3
Total Average	3.166666667	3.733333333	3.933333333

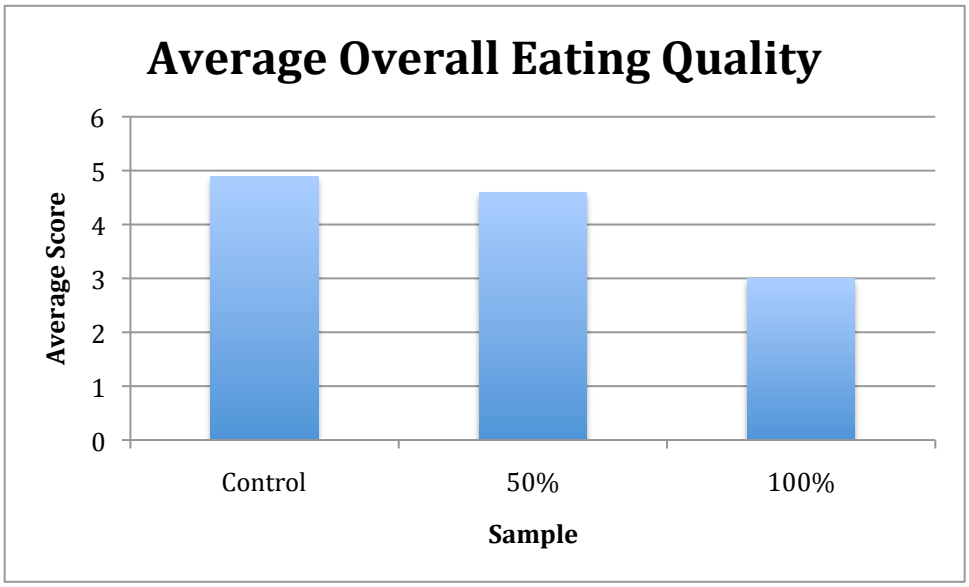
Overall Eating Quality

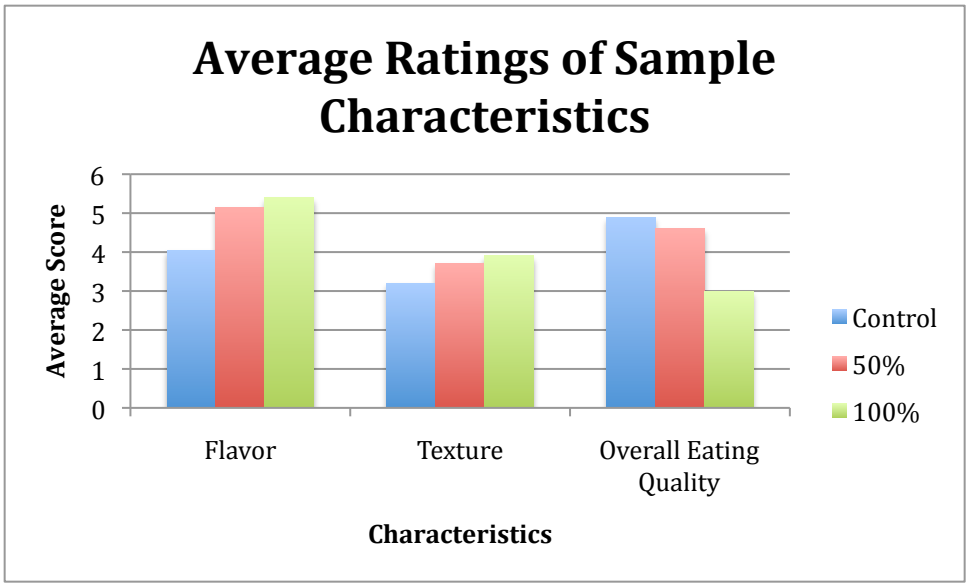
Control	50%	100%
7	6	1
5	7	2
6	4	2
1	3	5
1	6	6
5	6	4
2	2	1
6	3	2
6	5	4
4	3	3
3	7	7

	5	4	1
	4	5	6
	4	6	2
	5	6	5
	2	4	3
	7	2	1
	6	5	2
	7	2	2
	7	3	1
	7	4	3
	7	5	2
	7	1	3.5
	2	5	4
	7	5	2
	3	6	4
	6	5	4
	7	4	2
	4	7	5
	5	7	1
Total Average	4.933333333	4.6	3.016666667
Comments			
	Control	50%	100%
	Average	Yum	Odd
			Flavor too strong
			I liked the gritty texture & pungent flavor
	I like the Sweet flavor		
	Wish it was warm		
		Strong cheese flavor	
	No flavor		
		Pasta was hard	Pasta was hard
	Creamy & I liked the top texture	Not as smooth Strong flavor	Didn’t really like this one
	Was delicious		Had and after taste
	Very well balanced flavor		
		Good portion of cheese	
	It was ok		
	My favorite, good flavor	Pretty good	Has after taste


Average Flavor
Average Score
6
5
4
3
2
1
0
Control
50%
100%
Sample


Average Texture
Average Score
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Control
50%
100%
Sample


Average Overall Eating Quality
Average Score
6
5
4
3
2
1
0
Control
50%
100%
Sample


Average Ratings of Sample Characteristics
Average Score
6
5
4
3
2
1
0
Flavor
Texture
Overall Eating Quality
Characteristics
Control
50%
100%

Appendix B