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Pancakes with Flaxseed Meal

Abstract (words 94)

The occurrence of cardiovascular disease is rapidly growing in the United States. High levels of total cholesterol and LDL cholesterol are major risk factors for developing this disease. By decreasing these cholesterol levels and the inflammatory response that build up causes in the arteries, atherosclerosis and cardiovascular disease can be prevented. One factor that has been found to decrease total and LDL cholesterol and the inflammatory response is flaxseed. Adding flaxseed meal to pancake mix before cooking them will increase the consumption of flaxseed and decrease the prevalence of atherosclerosis causing cardiovascular disease.

Introduction

The problem at hand is cardiovascular disease and atherosclerosis. In 2006, 631,636 people died of heart disease. Heart disease caused 26% of deaths. That accumulates to more than one in every four people in the United States. Heart disease is the leading cause of death for both men and women. Half of the deaths due to heart disease in 2006 were women(Heron and others 2009). In 2010, heart disease will cost the United States $316.4 billion(Lloyd-Jones and others 2010). This total includes the cost of health care services, medications, and lost productivity. In an attempt to help solve this problem, adding flaxseed meal to pancakes has been tested.

Flaxseed, an edible oil seed/grain and one of the oldest arable crops, was recently acknowledged as a functional food. In addition to being the richest plant source of α-linolenic acid (ALA; 50–62% of flaxseed oil, or ≈22% of whole flaxseed) and lignans (range: 0.2–13.3 mg/g flaxseed), flaxseed is an essential source of dietary fiber, of which 25% is in the soluble form. Dietary soluble fiber has been proven to have cholesterol-lowering effects, causing significant decreases in total and LDL cholesterol(An and others 2009).The flax lignan complex-induced reduction in the progression of atherosclerosis is associated with reductions in oxidative stress(Prasad and others 2009). Oxidative stress is used to describe the effect of oxidation in which an abnormal level of reactive oxygen species, such as free radicals or the non-radicals, cause damage to specific molecules with injury to cells or tissue. Alpha linolenic acid has been shown to have positive effects on cardiovascular disease.

The doses of flaxseed found in studies range from 20 to 50 grams(An and others 2009). The mild pancake test has approximately 20 grams of flaxseed in the 5 small pancakes it produced, and the extreme pancake test has approximately 40 grams of flaxseed total in the 5 small pancakes it produced. The amount of flaxseed, if divided equally would be 4 grams per pancake and 8 grams per pancake. These amounts are not quite enough to show a significant change in blood lipids, but most people eat multiple pancakes and the amount in each pancake may be able to be altered in the future.

The statement of purpose is to make cheap, yet still delicious, pancakes with flaxseed meal added to them to help improve cardiovascular health and prevent cardiovascular disease from occurring. The dependent variable in the experiment is the flaxseed meal and the independent variable is the pancake batter.

Methods

The overall design is to add flaxseed meal to an add water only pancake batter. The procedures included putting the one cup of pancake mix in a bowl, adding ¾ of a cup of water, and then adding either, no flaxseed meal, 2 tablespoons, or 4 tablespoons of flaxseed meal to the bowl; mix it all together. Lastly, measure out ¼ of a cup of each variable and cook the pancakes in a frying pan on the stove.

The sensory scorecard had three questions on it concerning softness, overall taste preference, and color preference. Ranking the pancakes texture from 1-10, 1 being extremely soft and 10 being extremely hard, variable 402 scored 4 number 1 rankings, 2 number 2 rankings, 8 number 3 rankings, and 10 number 4 rankings. Variable 532 scored 2 number 2 rankings, 6 number 3 rankings, 9 number 4 rankings, and 7 number 5 rankings. Variable 751 scored 10 number 5 rankings, 6 number 6 rankings, 4 number 7 rankings, and 4 number 8 rankings. The overall preference was scored 1-3, 1 being the most preferable and 3 being the least preferable. Variable 402 scored 11 number 1 rankings, 6 number 2 rankings, and 9 number 3 rankings. Variable 532 scored 10 number 1 rankings, 13 number 2 rankings, and 1 number 3 rankings. Variable 751 scored 3 number 1 rankings, 5 number 2 rankings, and 14 number 3 rankings. The color preference was ranked 1-3 with 1 being the best color and 3 being the worst color. Variable 402 scored 13 number 1 rankings, 9 number 2 rankings, and 2 number 3 rankings. Variable 532 scored 10 number 1 rankings, 13 number 2 rankings, and 1 number 3 rankings. Variable 751 scored 1 number 1 rankings, 2 number 2 rankings, and 21 number 3 rankings. According to these tallies the 402 control was the softest. The 532 variable was the second softest. The variable 751 had the least softness. According to the tallies, variable 402 just barely came out to be the most preferred with variable 532 close behind and variable 751 the least preferred overall. According to these tallies, the variable 402 control had the best color, then the variable 532 variable had the second best color, and variable 751 had the least color preference. The addition of flaxseed meal to the pancakes seemed to make the pancakes a slightly darker shade of brown. The mild test pancakes looked a little darker and the extreme test pancakes were significantly darker.

The same recipe was followed for all three experiments that were performed. For the control, 1 cup Hungry Jack complete buttermilk pancake mix and ¾ cup of water as mixed together and cooked. For the mild test experiment the recipe was the same except only 2 tablespoons of Bob's Red Mill whole ground flaxseed meal was added. As for the extreme test experiment, 4 tablespoons of the whole ground flaxseed meal was added to the original recipe.

Three replications of each variable were completed. The control was labeled variable 402, the mild amount of flaxseed meal was variable 532, and the extreme amount of flaxseed meal was variable 751. There were twenty four people who were either asked previously to come in and sample the pancakes or who happened to be in Stone while the experiments were being performed. The pancakes were laid out in a row at random for the people to sample. There were forks available for people to use to test pieces of the pancakes. No butter or syrup were added to any of the pancakes to make sure that there were not any bias that could have altered the taste of the pancake itself.

This is a step by step process of how this experiment should be repeated if someone else would like to do so. Prepare cooking area with the essential utensils and ingredients. Double check procedures and recipe before you begin mixing the ingredients for all three variables. Start with the 1 cup dry pancake mix and ¾ cup water base by mixing them together. The control does not have any flaxseed meal additive. The mild test receives 2 tablespoons of flaxseed meal. The extreme test receives 4 tablespoons of flaxseed meal added to the batter. Mix each bowl and begin cooking. Pour the first mixture of the control variable onto the frying pan and remove when thoroughly cooked. Same will go for variable two and three. Evaluate products for correctness and accuracy. Clean up used materials and dirty workbench. Now that the work area is cleaned, analysis can begin in the food chemistry laboratory.

The Hunter Calorimeter will need to be standardized with the black and white tiles. While the machine standardizes, the pancakes can be put into Petri dishes and labeled accordingly. Once the calorimeter is standardized, then readings can be taken for each of the 3 variables. When the calorimeter tests are finished and recorded the next analysis will begin with the texture analyzer.

Remove the lids off of the Petri dishes and place each variable under the texture analyzer probe. The probe that will be used is the cylindrical shape. Set the machine to the correct test screen and start the test. Each piece of pancake will be analyzed 3 times. Move the piece of pancake around so that the three tests will render a decent average reading for each variable. Complete three tests on each of the three variables.

The water activity machine is the last test that will be done. This machine takes time to turn on and get standardized. It is beneficial to have one partner work on that while the other is running the other two machines. This will save the experimenters some time. Place a few small crumbles of the pancake in the plastic container that is to be inserted into the water activity machine for each of the three variables. Insert the each variable into the machine until the machine beeps or the light changes color. Then, the reading will appear on the screen that needs to be recorded. This concludes the entire set up, cooking, clean up, and analysis of the pancakes with flaxseed project.

Discussion

Many factors can attribute to changes in a food product. For this experiment, there were many variables that could have significantly changed the outcome of the results. According to study performed with flour and ingredient chlorination, many of the outcomes were similar compared to the flaxseed meal study. In both studies, ANOVA was used to calculate differences in means and evaluate the pancake product. It was proven that flour chlorination influenced pancake batter viscosity, geometry, and texture (Finnie and others 2006). This is comparable to the flaxseed experiment in that, when more flaxseed was added to the mixture, texture, viscosity, geometry, and as well as color, were all influenced by specific amounts. The results from the flour chlorination experiment indicated that individual ingredients dramatically influenced pancake batter, geometry, and texture (Finnie and others 20006). This strengthens the flaxseed experiment results and leads to ideas for future experiments.

In another study, automatic equipment for cooking pancakes was researched. The flaxseed meal experiment may have encountered errors when measuring exact proportions of each variable or cook time on the stove. The equipment study examines a batter supply system which dispenses a uniform quantity of batter for each pancake. It is a pan on both sides of the pancake and each side is cooked simultaneously (Weimer 2005). There is also a specific heat to which each pancake is cooked. This experiment is a highly controlled system. This is beneficial knowledge for future experiments. With this device, there is less room for error varying results. This tool should be used for an experiment, such as the flaxseed meal, in order to evenly cook each pancake and render more accurate and precise results.

As a take home message, it is imperative that consumers know that flaxseed meal has shown significant health benefits when added to food products. Flaxseed is one factor that has been found to decrease total and LDL cholesterol and the inflammatory response. Adding flaxseed meal to pancake mix before cooking them will increase the consumption of flaxseed and decrease the prevalence of atherosclerosis causing cardiovascular disease.

In the future, it is suggested that experimenters designate the exact timing of each pancake. This is a cause for debate because once the flax meal is added to the mix, the length of cooking time should be adjusted. It was also noticed that cook time and temperature are closely related. It is more favored to cook the flax meal pancakes over a low heat slowly so as to cook the pancake thoroughly and evenly.

Results

The results for the experiment are as follows.

Table 1: Water Activity

402 trail 1:	.966
532 trial 1:	.970

751 trial 1:	.974
402 trail 2:	.965
532 trail 2:	.965
751 trail 2:	.966
402 trail 3:	.971
532 trail 3:	.965
751 trial 3:	.976

Table 2: Texture Analyzer

402 trail 1:	59.0	59.0	109.5
532 trial 1:	46.0	33.5	35.8
751 trial 1:	162.7	153.6	123.3
402 trial 2:	111.7	76.3	26.4
532 trial 2:	186.0	81.9	126.9
751 trial 2:	69.7	96.7	90.9
402 trial 3:	52.4	64.3	58.1
532 trial 3:	100.1	122.0	107.4
751 trial 3:	41.4	68.2	55.7

Table 3: Colorimeter

	L	a	b
402 trial 1	36.28	12.10	16.46
532 trial 1	48.65	11.60	22.81
751 trial 1	46.72	10.94	20.67

	L	a	b
402 trial 2	40.09	12.17	18.41
532 trial 2	30.31	10.63	12.79

751 trial 2	51.65	7.07	18.49

	L	**a**	**b**
402 trial 3	62.08	4.34	21.40
532 trial 3	56.79	6.50	19.91
751 trial 3	48.28	9.11	18.40

The One-way Analysis of Variance, also known as, ANOVA was used to help calculate results and visually show the statistical significance flaxseed meal had on our product trials. First, an ANOVA was able to calculate the results from the water activity tests. The P value is 0.2723, which is considered not significant. Variation among column means was not significantly greater than expected by chance. ANOVA did not calculate the post tests because the P-value was greater than 0.05. ANOVA assumed that the data were sampled from populations with identical standard deviations. ANOVA also calculated and assumed that the data are sampled from populations that follow Gaussian distributions. This assumption is tested using the method Kolmogorov and Smirnov. There were too few values to test for normality during this test sequence.

Intermediate calculations. ANOVA table

Source of variation	Degrees of freedom	Sum of squares	Mean square
Treatments (between columns)	2	5.067E-05	2.533E-05
Residuals (within columns)	6	9.333E-05	1.556E-05
Total	8	0.0001440	

F = 1.629 =(MStreatment/MSresidual)

Summary of Data

Group	Number of Points	Mean	Standard Deviation	Standard Error of Mean	Median

402	3	0.9673	0.003215	0.001856	0.9660
532	3	0.9667	0.002887	0.001667	0.9650
751	3	0.9720	0.005292	0.003055	0.9740

			95% Confidence Interval	
Group	Minimum	Maximum	From	To
402	0.9650	0.9710	0.9593	0.9753
532	0.9650	0.9700	0.9595	0.9738
751	0.9660	0.9760	0.9589	0.9851

ANOVA was also used to calculate the texture analyzer results. In order to see the results and numbers clearly, trials one, two, and three were calculated individually based on the trial groups. The results are as follows.

For trial one of the texture analyzer the P value is 0.0021, which is considered very significant. Variation among column means was significantly greater than expected by chance. ANOVA also calculated the Tukey-Kramer Multiple Comparisons Test. For the results of this test, if the value of q is greater than 4.339 then the P value is less than 0.05.

Comparison	Mean Difference	q	P value
402 vs 532	37.400	3.088	ns P>0.05
402 vs 751	-70.700	5.838	* P<0.05
532 vs 751	-108.10	8.926	** P<0.01

		95% Confidence Interval	
Difference	Mean Difference	From	To
402 - 532	37.400	-15.146	89.946
402 - 751	-70.700	-123.25	-18.154

532 - 751	-108.10	-160.65	-55.554

ANOVA assumed that the data are sampled from populations with identical standard deviations. This assumption is tested using the method of Bartlett. ANOVA also assumed that the data are sampled from populations that follow Gaussian distributions. This assumption is tested using the method Kolmogorov and Smirnov. Again, there were too few values to test to receive results for this analysis.

Intermediate calculations. ANOVA table

Source of variation	Degrees of freedom	Sum of squares	Mean square
Treatments (between columns)	2	18083	9041.4
Residuals (within columns)	6	2639.8	439.96
Total	8	20723	

F = 20.550 =(MStreatment/MSresidual)

Summary of Data

Group	# of Points	Mean	Std. Deviation	Std. Error of Mean	Median
402	3	75.833	29.156	16.833	59.000
532	3	38.433	6.653	3.841	35.800
751	3	146.53	20.629	11.910	153.60

			95% Confidence Interval	
Group	Minimum	Maximum	From	To
402	59.000	109.50	3.400	148.27

532	33.500	46.000	21.905	54.962
751	123.30	162.70	95.285	197.78

The following results are from ANOVA concerning trial two of the texture analyzer. The P value is 0.2346, which is considered not significant. Variation among column means is not significantly greater than expected by chance. Post tests were not calculated because the P value was greater than 0.05. ANOVA assumed that the data are sampled from populations with identical standard deviations. This assumption was tested using the method of Bartlett. ANOVA also assumed that the data are sampled from populations that follow Gaussian distributions. This assumption is tested using the method Kolmogorov and Smirnov. There were too few values to test for these results.

Intermediate calculations. ANOVA table

Source of variation	Degrees of freedom	Sum of squares	Mean square
Treatments (between columns)	2	5921.2	2960.6
Residuals (within columns)	6	9528.7	1588.1
Total	8	15450	

F = 1.864 =(MStreatment/MSresidual)

Summary of Data

Group	# of Points	Mean	Std. Deviation	Std. Error of Mean	Median
402	3	71.467	42.855	24.742	76.300
532	3	131.60	52.209	30.143	126.90
751	3	85.767	14.213	8.206	90.900

95% Confidence Interval

Group	Minimum	Maximum	From	To
402	26.400	111.70	-34.999	177.93
532	81.900	186.00	1.895	261.30
751	69.700	96.700	50.456	121.08

The following represents the results of the ANOVA test for trial three of the texture analyzer. The P value is 0.0012, which is considered very significant. Variation among column means is significantly greater than expected by chance. The Tukey-Kramer Multiple Comparisons Test shows that if the value of q is greater than 4.339 then the P value is less than 0.05.

Comparison	Mean Difference	q	P value
402 vs 532	-51.567	8.395	** P<0.01
402 vs 751	3.167	0.5155	ns P>0.05
532 vs 751	54.733	8.910	** P<0.01

	95% Confidence Interval		
Difference	Mean Difference	From	To
402 - 532	-51.567	-78.220	-24.913
402 - 751	3.167	-23.487	29.820
532 - 751	54.733	28.080	81.387

ANOVA assumed that the data are sampled from populations with identical standard deviations. This assumption is tested using the method of Bartlett. ANOVA also assumed that the data are sampled from populations that follow Gaussian distributions. This assumption is tested using the method Kolmogorov and Smirnov. Once again, there are too few values to test to receive these results of normality.

Intermediate calculations. ANOVA table

Source of variation	Degrees of freedom	Sum of squares	Mean square
Treatments (between columns)	2	5664.9	2832.4
Residuals (within columns)	6	679.19	113.20
Total	8	6344.1	

F = 25.022 =(MStreatment/MSresidual)

Summary of Data

Group	# of Points	Mean	Std. Deviation	Std. Error of Mean	Median
402	3	58.267	5.952	3.436	58.100
532	3	109.83	11.151	6.438	107.40
751	3	55.100	13.410	7.742	55.700

95% Confidence Interval

Group	Minimum	Maximum	From	To
402	52.400	64.300	43.481	73.053
532	100.10	122.00	82.131	137.54
751	41.400	68.200	21.785	88.415

Lastly, ANOVA was used to calculate the colorimeter results. In order to see the results and numbers clearly, trials one, two, and three were calculated individually based on the trial groups. The results are as follows.

The following results are for trial one of the colorimeter. ANOVA calculated the P value as 0.0002, which is considered extremely significant. Variation among column means is significantly greater than expected by chance. The Tukey-Kramer Multiple Comparisons Test shows that if the value of q is greater than 4.339 then the P value is less than 0.05.

Comparison	Mean Difference	q	P value
L vs a	32.337	13.073	*** P<0.001
L vs b	23.903	9.664	** P<0.01
a vs b	-8.433	3.409	ns P>0.05

95% Confidence Interval

Difference	Mean Difference	From	To
L - a	32.337	21.604	43.069
L - b	23.903	13.171	34.636
a - b	-8.433	-19.166	2.299

ANOVA assumed that the data are sampled from populations with identical standard deviations. This assumption was tested using the method of Bartlett. ANOVA also assumed that the data are sampled from populations that follow Gaussian distributions. This assumption is tested using the method Kolmogorov and Smirnov. There were too few values in order to calculate the normality for this test.

Intermediate calculations. ANOVA table

Source of variation	Degrees of freedom	Sum of squares	Mean square
Treatments (between columns)	2	1688.2	844.08

Residuals (within columns)	6	110.13	18.355
Total	8	1798.3	

F = 45.986 =(MStreatment/MSresidual)

Summary of Data

Group	# of Points	Mean	Std. Deviation	Std. Error of Mean	Median
L	3	43.883	6.655	3.842	46.720
a	3	11.547	0.5818	0.3359	11.600
b	3	19.980	3.231	1.865	20.670

95% Confidence Interval

Group	Minimum	Maximum	From	To
L	36.280	48.650	27.350	60.417
a	10.940	12.100	10.101	12.992
b	16.460	22.810	11.954	28.006

The following results are calculations from the ANOVA for the second trial of the colorimeter. The P value is 0.0030, which is considered very significant. Variation among column means is significantly greater than expected by chance. The Tukey-Kramer Multiple Comparisons Test shows that if the value of q is greater than 4.339 then the P value is less than 0.05.

Comparison	Mean Difference	q	P value
L vs a	30.727	8.034	** P<0.01

L vs b	24.120	6.307	*	P<0.05
a vs b	-6.607	1.727	ns	P>0.05

95% Confidence Interval

Difference	Mean Difference	From	To
L - a	30.727	14.133	47.321
L - b	24.120	7.526	40.714
a - b	-6.607	-23.201	9.987

ANOVA assumed that the data are sampled from populations with identical standard deviations. This assumption is tested using the method of Bartlett. ANOVA also assumed that the data are sampled from populations that follow Gaussian distributions. This assumption is tested using the method Kolmogorov and Smirnov test. There were too few values in order to calculate results for normality.

Intermediate calculations. ANOVA table

Source of variation	Degrees of freedom	Sum of squares	Mean square
Treatments (between columns)	2	1569.6	784.78
Residuals (within columns)	6	263.27	43.879
Total	8	1832.8	

F = 17.885 =(MStreatment/MSresidual)

Summary of Data

Group	# of Points	Mean	Std. Deviation	Std. Error of Mean	Median

L	3	40.683	10.682	6.167	40.090
a	3	9.957	2.616	1.510	10.630
b	3	16.563	3.268	1.887	18.410

	95% Confidence Interval			
Group	Minimum	Maximum	From	To
L	30.310	51.650	14.145	67.222
a	7.070	12.170	3.458	16.455
b	12.790	18.490	8.444	24.682

Lastly, ANOVA calculated results for trial three for the colorimeter test. The P value is < 0.0001, which is considered extremely significant. Variation among column means is significantly greater than expected by chance. The Tukey-Kramer Multiple Comparisons Test shows that if the value of q is greater than 4.339 then the P value is less than 0.05.

Comparison	Mean Difference	q	P value
L vs a	49.067	19.595	*** P<0.001
L vs b	35.813	14.303	*** P<0.001
a vs b	-13.253	5.293	* P<0.05

		95% Confidence Interval	
Difference	Mean Difference	From	To
L - a	49.067	38.202	59.931
L - b	35.813	24.949	46.678

a - b	-13.253	-24.118	-2.389

ANOVA assumed that the data are sampled from populations with identical standard deviations. This assumption is tested using the method of Bartlett. ANOVA also assumed that the data are sampled from populations that follow Gaussian distributions. This assumption is tested using the method Kolmogorov and Smirnov, although there were too few values to test for normality.

Intermediate calculations. ANOVA table

Source of variation	Degrees of freedom	Sum of squares	Mean square
Treatments (between columns)	2	3865.8	1932.9
Residuals (within columns)	6	112.86	18.810
Total	8	3978.6	

F = 102.76 =(MStreatment/MSresidual)

Summary of Data

Group	# of Points	Mean	Std. Deviation	Std. Error of Mean	Median
L	3	55.717	6.962	4.020	56.790
a	3	6.650	2.389	1.379	6.500
b	3	19.903	1.500	0.8660	19.910

95% Confidence Interval

Group	Minimum	Maximum	From	To

L	48.280	62.080	38.420	73.013
a	4.340	9.110	0.7161	12.584
b	18.400	21.400	16.177	23.630

(Attached are the figures that support the experiment)

References

An P, Yu D, Demark-Wahnefried W, Franco O, Lin X. 2009. Meta-analysis of the effects of flaxseed interventions on blood lipids. *The American Journal of Clinical Nutrition*.

Finnie SM, Bettge AD, Morris CF. 2006. Influence of Flour Chlorination and Ingredient Formulation on the Quality Attributes of Pancakes. *Cereal Chemistry*. 83(6): 684-691.

Heron MP, Hoyert DL, Murphy SL, Xu JQ, Kochanek KD, Tejada-Vera B. 2009. Deaths: Final data for 2006 [PDF–2.3M]. *National Center for Health Statistics*. National Vital Statistics Reports. 57(14).

Lloyd-Jones D, Adams RJ, Brown TM, et al. Heart Disease and Stroke Statistics—2010 Update. 2010. A Report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation*. 121:e1-e170.

Prasad K. 2009. Flax Lignan complex slows down the progression of atherosclerosis in Hyperlipidemic rabbits. *Journal of Cardiovascular Pharmacological and Therapeutics*. 14(1):38-48.

Weimer W. Automatic Equipment for Cooking of Pancakes. *German Patent Utility Model*. 2005.