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Project: Finding the Maillard Reaction of Bread with Differing Times in the Oven

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Project: Finding the Maillard Reaction of Bread with Differing Time in the Oven
Title: Procedure for experiment

1. 1 tablespoon of yeast, 2 cups of water, and a pinch of sugar were added to a large bowl.
2. The mixture was allowed to rest for 5-10 minutes until it was foaming.
3. The rest of the sugar was added as well as 2 teaspoons of salt, 2 tablespoons of vegetable oil, and 3 cups of all-purpose flour.
4. Then the mixture was mixed well.
5. While the mixture was being stirred ½ cup of flour at a time was added until dough begins to firm up.
5. The dough was kneaded for 5-8 minutes.
6. The dough mixture was then placed in a large, greased bowl with cooking spray.
7. Plastic wrap was then placed over the greased bowl with the dough inside.
8. The dough then rested for 1 1/2 hours, until it was doubled in size.
9. The dough was then divided into 2 equal sections, or 8 ounces each, and put inside the sprayed loaf pans from cooking oil.
10. Four loaf pans were used in total for all the loaves of bread made. Each bread pan was 11.02" x 5.91" x 2.76".
11. Two pieces of greased plastic wrap were placed on the loaf pans for the dough to rise for another 45-60 minutes.
12. The oven racks were placed into the second to the bottom rack in the oven model Jen-Air Dual Convection Oven, Model Number WW304309, manufactured by Maytag Appliances.
13. The oven was preheated to 350 degrees Fahrenheit.
14. A total of fifteen loaves of bread were made in the experiment.
15. The recipe was made seven and a half times each time consistent to the last.
16. The three batches of dough were not baked and were set to be the control group.
17. The twelve following bread loaves were baked for the following times: 20, 40, 60, and 80 minutes.

Project: Finding the Maillard Reaction of Bread with Differing Times in the Oven
Title: Procedure for experiment continued

19. The Hunter Browning Index by measuring the different color changes using the parameters of lightness(L), redness(a), yellowness(b), and delta E for total color change was used.

20. The scientific app on smartphones that measures Hunter Browning Index was downloaded the name being "Color Analysis Palettes Shades".

21. The scientific mode was used to measure the Hunter Browning Index parameters from 6 inches away from each loaf's crust.

22. The data collected from the app concerning the Hunter Browning Index was compiled into the data tables listed below and averaged.

23. Then the data was be plugged into two equations: $x = (a + 1.75L)/ (5.645L + a – 0.3012b)$ and $BI = 100(x – 0.31)/ 0.172$ to find the Browning Index. This experiment was completed within 24 hours.

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Project: Finding the Maillard Reaction of Bread with Differing Times in the Ove
Title: Data Analysis Procedure using Hunter Browning Index

Data Analysis Procedure:

The data was collected by the smartphone app "Color Analysis Palettes Shades". Each loaf of bread had four photos taken. The average of the four numbers in each column of the data table 1 listed below was found. The app shows the Hunter Browning Index. The Hunter Browning Index used the values from the "L", "a", and "b" color scale.

The "L" value represented the how light or dark the sample color was from a scale of 0 (black) to 100 (white).

The "a" value represented the redness (+) or greenness (-) of the sample color.

The "b" value represented the yellowness (+) or blueness (-) of the sample color.

Delta E was a metric for the total color difference in the color sample.

Two equations were used to find the Browning Index.

Equation 1: $x = (a + 1.75L)/ (5.645L + a - 0.3012b)$

Equation 2: $BI = 100(x - 0.31)/ 0.172$

The values of "L", "a", and "b" were plugged in and the average of each loaf of bread was plugged into the first equation, then the answer from equation 1 was plugged into equation 2. Then the Browning Index was found. The average of the browning index for the three loaves of bread in each time section was then found and added to Data Table 2.

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Project: Finding the Maillard Reaction of Bread with Differing Times in the Oven

Title: Data Table 1: Measuring Hunter Browning Index parameters

	A	B	C	D	E
1	Loaf Number	Baking Time	Lightness (L)	Redness (a)	Yellowness (b)
2	Loaf 1	0	73.4	-7.1	41.9
3	Loaf 1	0	57.8	-7.9	44.3
4	Loaf 1	0	63.5	-6.6	50.9
5	Loaf 1	0	64.7	-7.6	44.9
6	Loaf 2	0	68.2	-5.8	23.8
7	Loaf 2	0	76.2	-7.7	39.9
8	Loaf 2	0	79.6	-8.2	33.7
9	Loaf 2	0	81.9	-7.9	35.7
10	Loaf 3	0	70.2	-7.2	25.5
11	Loaf 3	0	67.2	-7.5	28.9
12	Loaf 3	0	73.0	-8.2	29.3
13	Loaf 3	0	77.2	-7.2	29.9
14	Loaf 4	20	60.9	-5.2	31.3
15	Loaf 4	20	62.1	-5.1	35.0
16	Loaf 4	20	66.8	-4.1	35.5
17	Loaf 4	20	62.4	-5.4	33.9
18	Loaf 5	20	60.6	-6.6	31.4
19	Loaf 5	20	66.4	-2.2	32.8
20	Loaf 5	20	63.0	-4.1	32.0
21	Loaf 5	20	63.7	-2.7	31.9
22	Loaf 6	20	66.3	-3.0	32.7
23	Loaf 6	20	63.9	-3.1	29.5
24	Loaf 6	20	64.8	-2.8	31.8
25	Loaf 6	20	60.3	-3.8	27.3
26	Loaf 7	40	57.0	8.4	35.5
27	Loaf 7	40	58.3	3.6	39.9
28	Loaf 7	40	59.8	3.5	39.7
29	Loaf 7	40	61.9	4.0	40.8
30	Loaf 8	40	59.9	12.2	38.7
31	Loaf 8	40	58.4	10.8	39.8
32	Loaf 8	40	52.1	13.7	39.8
33	Loaf 8	40	55.9	10.0	41.3

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Project: Finding The Maillard Reaction of Bread with Differing Times in the Oven

Title: Data Table 1: Measuring Hunter Browning Index Parameters

1	Loaf Number	Baking Time	Lightness (L)	Redness (a)	Yellowness (b)
34	Loaf 9	40	58.3	7.4	34.8
35	Loaf 9	40	58.1	7.5	42.8
36	Loaf 9	40	57.2	5.5	41.1
37	Loaf 9	40	56.0	7.6	32.3
38	Loaf 10	60	47.6	15.2	37.5
39	Loaf 10	60	54.4	8.8	37.8
40	Loaf 10	60	42.2	15.0	35.6
41	Loaf 10	60	50.4	7.3	38.0
42	Loaf 11	60	50.4	14.9	39.8
43	Loaf 11	60	44.0	11.1	35.6
44	Loaf 11	60	44.0	16.8	42.7
45	Loaf 11	60	52.7	13.3	38.0
46	Loaf 12	60	51.1	12.8	44.4
47	Loaf 12	60	51.7	10.8	39.7
48	Loaf 12	60	53.3	9.1	39.5
49	Loaf 12	60	49.3	13.7	39.4
50	Loaf 13	80	37.5	11.9	30.2
51	Loaf 13	80	50.9	9.2	31.8
52	Loaf 13	80	39.0	12.7	34.3
53	Loaf 13	80	42.6	15.0	39.1
54	Loaf 14	80	44.5	14.3	33.6
55	Loaf 14	80	46.6	11.4	34.4
56	Loaf 14	80	44.9	14.3	33.5
57	Loaf 14	80	34.3	9.7	31.7
58	Loaf 15	80	43.7	11.6	32.5
59	Loaf 15	80	45.5	15.1	37.6
60	Loaf 15	80	39.7	10.7	32.9
61	Loaf 15	80	43.6	15.6	36.8

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Project: Finding the Maillard Reaction of Bread with Differing Times in the Oven

Title: Data Table 2: Averages of Measuring Hunter Browning Index - Loaves

Data Table 3: Averages of Measuring Hunter Browning Index - Batches

	Loaf Number	Baking Time	Lightness (L) Average Loaf	Redness (a) Average Loaf	Yellowness (b) Average Loaf
2	Loaf 1	0	64.85	-7.3	45.5
3	Loaf 2	0	76.475	-7.4	33.275
4	Loaf 3	0	71.9	-7.525	28.4
5	Loaf 4	20	63.05	-5.0	33.925
6	Loaf 5	20	63.425	-3.9	32.025
7	Loaf 6	20	63.825	-3.175	30.325
8	Loaf 7	40	59.25	4.875	38.975
9	Loaf 8	40	56.575	11.675	39.9
10	Loaf 9	40	57.4	7	37.75
11	Loaf 10	60	48.65	11.575	37.225
12	Loaf 11	60	47.775	14.025	39.025
13	Loaf 12	60	51.35	11.6	40.75
14	Loaf 13	80	42.5	12.2	33.85
15	Loaf 14	80	42.575	12.425	33.3
16	Loaf 15	80	43.125	13.25	34.95

	Loaf Batches	Baking Time	Lightness (L) Average Batches
2	Loaves 1,2,3	0	71.075
3	Loaves 4,5,6	20	63.43333333
4	Loaves 7,8,9	40	57.74166667
5	Loaves 10,11,12	60	49.25833333
6	Loaves 13,14,15	80	42.73333333

Redness (a) Average Batches	Yellowness (b) Average Batches	Delta E
-7.408333333	35.725	9.119
-4.008333333	32.09166667	14.8
7.85	38.875	9.6273
12.4	39	8.2033
12.625	34.03333333	

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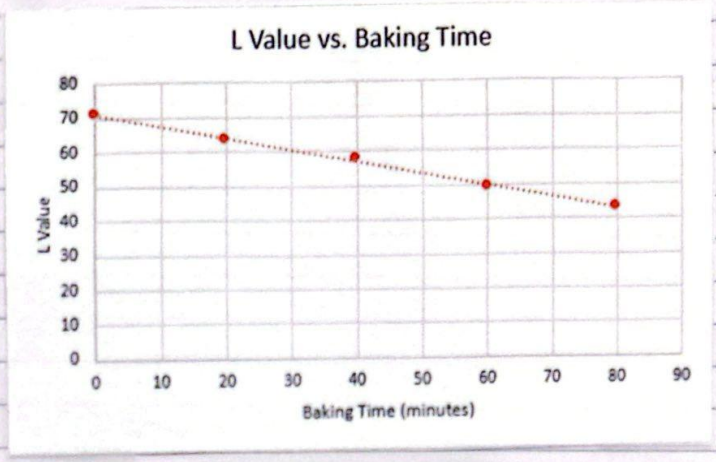
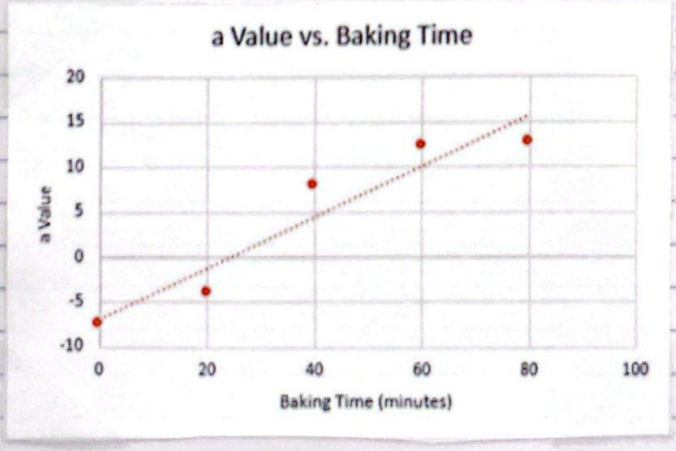
Project: Finding the Maillard Reaction of Bread with Differing Times in the Oven
Title: "L" Value & "a" value vs. Baking Time Graphs





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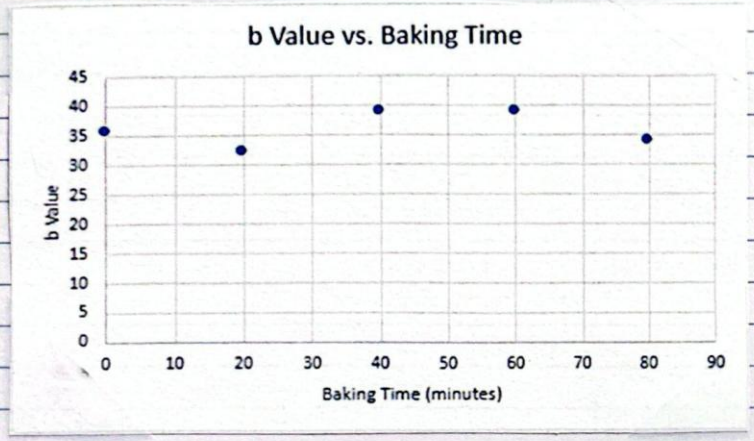
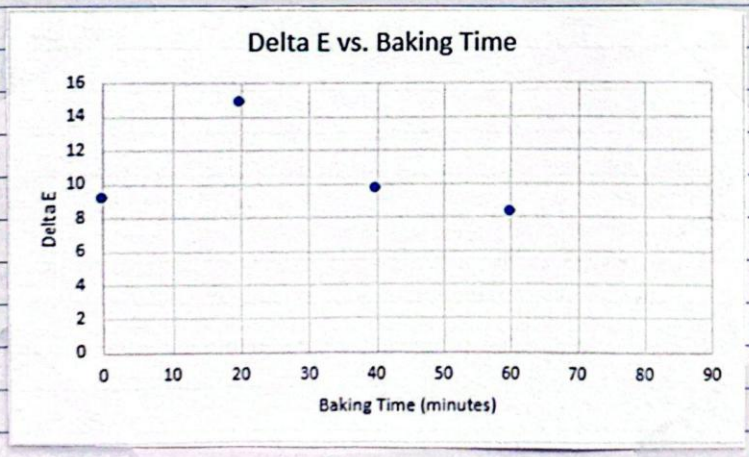
8.

Project: Finding the Maillard Reaction of Bread with Differing Times in the Oven
Title: "b" Value & Delta E vs. Baking Time Graphs





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Project: Finding the Maillard Reaction of Bread with Differing Times in the Oven
Title: Material List for experiment

Material List:

Each time the recipe was made the following ingredients were used:

2 cups of warm water were used for the bread dough recipe.

1 tablespoon active dry yeast was used for the bread dough recipe.

¼ cup of granulated sugar was used for the bread dough recipe.

2 teaspoons of salt were used for the bread dough recipe.

2 tablespoons of vegetable oil were used for the bread dough recipe.

4-5 ½ cups of all-purpose flour were used for the bread dough recipe.

Cooking spray was used on the inside of pans to prevent the dough from sticking.

Large Mixing bowl was used to mix ingredients for the bread dough.

Plastic wrap was used to cover the bread pans for rising.

Ruler to measure the distance between the smartphone and loaf of bread when taking the pictures for the browning index.

Four bread pans that are 11.02" x 5.91" x 2.76" were used to bake the loaves of bread.

An oven, specifically oven model Jen-Air Dual Convection Oven, Model Number WW304309, manufactured by Maytag Appliances, was the oven used for baking loaves of bread.

Oven mitts or hot pads were used to prevent getting burned from the oven.

Cellular device with color analysis app "Color Analysis Palettes Shades" was downloaded to measure the browning index of the Maillard reaction.

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Project: Finding the Maillard Reaction of Bread with Differing Times in the Oven
Title: Risk and safety precautions for experiment

Risk and Safety:

The main risk of this experiment is using the oven. The oven was at a hot temperature, so cautious precautions were taken when taking the bread in and out of the oven.

To avoid injury, a parental guardian placed the bread pans in and out of the oven. (They used either oven mitts or hot pads).

Since this experiment contains cooking, the CDC handwashing procedures were used:

The CDC handwashing procedures include:

1. Hands were put under running water, the tap then turned off, and then soap was applied.
2. Hands were lathered everywhere including the backs, in between fingers, fingertips, and under nails.
3. Hands were then scrubbed.
4. Hands were then rinsed well underneath clean running water.
5. Hands were then dried using a clean towel or air dryer.

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Project: Finding the Maillard Reaction of Bread with Differing Times in the Oven
Title: Photos of 15 loaves of Bread

Photo: Loaf 1

Photo: Loaf 2

Photo: Loaf 3

Photo: Loaf 4

Photo: Loaf 5

Photo: Loaf 6

Photo: Loaf 7

Photo: Loaf 8

Photo: Loaf 9

Each Picture was taken in the app "Color Analysis Palettes Shades" to determine Hunter Browning Index.
Each Picture was taken 6 inches away from the loaf of bread.

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Project: Finding the Maillard Reaction of Bread With Differing Times in the Oven
Title: Photos of 15 loaves of Bread

Photo: Loaf 10

Photo: Loaf 11

Photo: Loaf 12

Photo: Loaf 13

Photo: Loaf 14

Photo: Loaf 15

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