I. The Effect of Cereal Replacement on Texture and Taste in Rice Krispie’s Treats

II. Abstract:

Rice Krispie’s Treats are easy and delicious desserts that are enjoyed by many consumers. However, these treats contain little nutritional value. One nutrient in which they are lacking is fiber. Many Americans are not meeting their daily fiber needs. By replacing the cereal contained in this commonly enjoyed dessert with a cereal rich in fiber, a dessert with increased nutritional value could be developed. Three different types of Rice Krispie’s Treats were produced. The original recipe was used to create the control, a half Rice Krispie’s and half Kashi GoLean cereal treat was produced, and a complete Kashi GoLean cereal treat was made. These three treats were examined and analyzed by a sensory panel, Texture Analyzer, and Hunter Colorimeter. The Texture Analyzer indicated that as Kashi GoLean cereal content increased, so did the grams of force needed to break the treat. The Hunter Colorimeter indicated that the color of the treats became darker as more Kashi GoLean cereal was incorporated. In general, the sensory panel indicated that they enjoyed the taste and texture of both the control and the mixed treats, but did not enjoy the texture or taste of the treats with a complete cereal replacement. Overall, it was found that replacing Rice Krispie’s Treats completely with the fiber rich cereal Kashi GoLean sacrificed taste and texture and was not enjoyed by consumers. However, a mixture of cereal could increase the nutritional value without forfeiting major changes in texture and taste.
Many Americans are not meeting their daily fiber needs. In fact, according to the American Dietetic Association, the typical American eats only about 11 grams of fiber a day, while the recommended intake is 20 to 30g per day (Papazian, 2007). Many people don’t understand how fiber benefits the body. Research has shown that increasing dietary fiber intake may decrease the risk of coronary heart disease events, cardiovascular disease events, and mortality from all causes (Bazzano, 2003). Furthermore, according to Jenkins, incorporation of viscous fibers into a wide variety of foods results in significant reductions in total cholesterol and in the ratio of LDL to HDL cholesterol (2002). While fiber has been shown to reduce the risk of heart disease, it also has many other benefits. Fiber adds bulk to meals so it may be helpful in fighting frequent hunger and therefore may contribute to weight loss. Furthermore, studies have shown that high-fiber diets can exert a protective effect against colon cancer and perhaps other types of cancer as well (Campbell, 2001).

By incorporating fiber into foods that are generally well-liked by the public, fiber intake could increase and people could reap the benefits of a high-fiber diet. Rice Krispie’s Treats are a well known and popular dessert. However, this cereal contains zero grams of fiber per serving (Kellogg’s Cereal, 2007). On the other hand, Kashi GoLean Cereal contains 10 grams of fiber per serving (GoLean, 2007). Replacing Rice Krispie’s with Kashi Go Lean could lead to a higher fiber dessert that still tastes great. While Kashi GoLean Cereal is an excellent source of fiber, some people may find it unpalatable. However, if coated with butter and marshmallows, taste may not be an issue. This led to the development of 3 samples. The first was the original Rice Krispie’s Treats recipe, the second contained half Rice Krispie’s and half Kashi GoLean, and the last was made completely with Kashi GoLean Cereal.
Several methods were used to evaluate the products created. Objective methods included the Texture Analyzer and Hunter Colorimeter. The Texture Analyzer evaluated the texture of each treat developed while the Hunter Colorimeter performed a color evaluation of each sample. The subjective means consisted of a sensory panel that evaluated the products on taste and texture. The sensory panel consisted of ten semi-trained participants.

The purpose of this experiment is to make a healthier version of a long time popular dessert without sacrificing desirable flavor and texture. The independent variable of this project will be the two cereals. The dependent variables will be texture as measured by the Texture Analyzer, color as evaluated by the Hunter Colorimeter and palatability as measured by a taste panel.

IV. Methods

A standard protocol was used in the development of these three samples. The Kellogg’s Rice Krispie’s Treats Original Recipe was followed with several cereal variations (Kellogg’s Original, 2007). The recipes used for each sample are specified below. First, butter was melted into a saucepan over low heat. Then, mini marshmallows were added to the butter and stirred until the mixture was completely melted. At this point, the cereal amounts specified for each recipe were added. This mixture was pressed into an 8x8x2 inch dish which was coated with cooking spray. The product was allowed to cool at room temperature for one hour. Once cooled, the products were cut into 10 samples for evaluation by the sensory panel. An example of the sensory scorecard is attached.

Standard Recipe:

- Butter- 22g
- Mini marshmallows- 100g
Each sample was prepared in the same way each time. Since three trials were conducted, each sample was made 3 times. The samples were assigned numbers randomly to eliminate bias by the sensory panel. The control recipe was 873, the mixed recipe was 204 and the fully substituted recipe was 985. Each member of the sensory panel was given the mixed sample first, the control second, and the fully substituted sample last. Each sample was distributed by the researcher. Each panel member was asked to rate each sample on taste and texture and then finally to rank the samples in the order that they liked them. A random sample of participants made up the sensory panel in order to produce the best results.

Next, the samples were evaluated using objective measures. Each sample from the three trials was evaluated by the Texture Analyzer and the Hunter Colorimeter. The standard protocols for operation of the equipment were followed as instructed by The Food Chemistry Manual (Weaver, 2003). The Texture Analyzer was used to directly measure the force needed to break each treat. A knife probe was used. The setting used for evaluation of the treats was “cookies”. This was selected because this was the closest item to the product created. Numbers obtained from the T.A. were estimated by the researcher by looking at the graph created by the machine. This is because the T.A. was experiencing problems on the day of the product evaluation. This approximation may have skewed the results due to human error and imprecision.

The Hunter Colorimeter was used to evaluate the color of the products. The measurements taken by this machine were exhibited through L, a, and b values. Samples
from each trial were placed in a petri dish and evaluated by the Colorimeter. The values given by the machine were recorded and evaluated.

V. Discussion

Before reporting the results of the various tests, potential sources of error should be discussed. First, the objective means in the form of the Texture Analyzer and Hunter Colorimeter will be assessed. As previously mentioned, on the day of product evaluation the T.A. was not giving numerical values for grams of force. It was only giving a graphical analysis of the breaking strength. This led to the researcher having to approximate the breaking strength of each treat based on the graph. This could have led to human error in reading the data and consequently flaws in the data.

The Hunter Colorimeter was working as usual on the day of testing. However, error in sample preparation could have skewed the results. Lastly, error in subjective data will be discussed. Subjective data is hard to regulate. It is difficult to control each individual on the sensory panel. Individuals do exhibit bias where as machines do not. Subjects on the panel could have shown bias simply based on what the product looked like before they tasted it. Furthermore, differences in preference on texture and taste of foods could have resulted in error. One final source of error for the sensory panel could have been the consumption of food or liquid prior to the test which could have altered taste and therefore skewed their preferences and evaluations of the products.

The creation of the modified Rice Krispie’s Cereal Treats yielded many results in terms of subjective and objective means. The first objective measure used was the Texture Analyzer. The results from this evaluation can be found in Table 1. These results showed that the breaking strength of the treats increased as the Kashi GoLean Cereal increased. A graph of
the results can be found in Figure 1. This is what would be expected considering the fiber content increased with increased GoLean Cereal. In fact, as Campbell stated in his article, fiber adds bulk to foods and thus would increase roughness of the food. This supports why breaking strength increased with increased fiber and furthermore why the sensory panel rated the complete cereal replacement cereal as the most rough in terms of texture, as will be discussed later (2001).

The next means of objective evaluation was the use of the Hunter Colorimeter. The first parameter evaluated was the L-value which evaluated lightness and darkness of the sample. The data collected from this test can be found in Table 2. Results showed that the samples became darker as more Kashi GoLean was added. The results for these L-values are shown in Figure 2. This would make sense because the coloration of the GoLean Cereal is darker than that of Rice Krispie’s Cereal. The next parameter evaluated was the a-value. The a-values measure the products in terms of the green to red spectrum. These results are shown in Figure 3. Results showed a slight lean towards the red. However, overall, the results from all the treats were very similar and not statistically different or significant. This is because the colors measured in this test were not of major involvement to this study.

Finally, the b-values were evaluated. The results from these values can be found in Figure 4. The b-values measure the product in terms of the yellow to blue spectrum. Values for this tended to lean towards the yellow coloration. The values obtained were fairly similar between the products, with the control recipe yielding slightly higher values when compared to the other two samples. This would suggest that the control had a slightly more yellow tint than the others. Rice Krispie’s Cereal is more yellow than Kashi GoLean and thus, this is congruent with what would be expected.
The last means of evaluation was the subjective testing. This was performed by use of a sensory panel consisting of 10 semi-trained participants. The results of this evaluation can be found in Table 3. The results show that all but one participant chose the control sample as their favorite, with all participants choosing the complete cereal replacement cereal as their least favorite. These results are represented in Figure 5. While the majority of participants chose the control as their favorite sample, the unstructured rating system that was used to rate each individual sample showed that the control sample and the mixed sample were not significantly different in terms of taste and texture. All participants ranked these samples very closely in terms of taste and texture. This would lead to the assumption that a moderate incorporation of fiber can still maintain texture and taste.

However, all participants ranked the complete cereal replacement cereal very low in terms of taste and texture. A study by Fernandez-Garcia performed a similar experiment. She investigated how fortification of yogurt with fiber would affect texture and flavor. The reduced calorie yogurts were fortified with 1.32% oat fiber and supplemented with either sucrose or fructose for sweetness. She found that the addition of fiber decreased the overall flavor quality and that fiber addition improved the body and texture of the yogurts but lowered the overall scores for body and texture in the yogurts (1998). This further supports the idea that a high fortification of fiber into foods cannot maintain texture or flavor of the product.

One further article by Redgwell also had this finding. Redgwell discusses in his article "Dietary fiber as a versatile food component: an industrial perspective" the difficulties of adding fiber to foods without sacrificing appealing texture. Redgwell states that dietary fiber could be included in many recipes providing that they did not compromise the sensory
quality of the product. He goes on to say that fiber coming from cereal brans have limited functionality in terms of water control and would result in some negative sensory attributes. However, new sources of dietary fiber with a broader spectrum of technological functionality have been developed. These include: hydrocolloids, bioactive oligosaccharides, and whole plant cell wall materials (2005). This article provided ideas for future work in this field.

If performing this experiment again, the use of alternate fiber sources could be investigated. The sources suggested by Redgwell would potentially be able to incorporate fiber while maintaining product texture and taste. However, another cereal source could also be investigated. For instance, “All Bran” or some other high fiber cereal could act as the replacement cereal to see if that made a difference in the sensory evaluation. There are many possibilities for fiber incorporation into a variety of foods, especially with the development of products that don’t affect the texture and flavor of those foods.

Overall, including a large amount of fiber into products can have a significant effect on texture and taste. However, if used in moderation, texture and taste are not significantly altered and can therefore add nutritional value while still appealing to the consumer.

**VI. Results**

**Table 1:** Texture of each sample as measure by the Texture Analyzer in grams

<table>
<thead>
<tr>
<th>Sample</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control-873</td>
<td>2380 g</td>
<td>2450 g</td>
<td>2550 g</td>
</tr>
<tr>
<td>Mixed-204</td>
<td>4650 g</td>
<td>5025 g</td>
<td>4060 g</td>
</tr>
<tr>
<td>Complete Substitution-985</td>
<td>8725 g</td>
<td>9025 g</td>
<td>8590 g</td>
</tr>
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</table>
**Table 2:** Color evaluation of each sample as measured by the Hunter Colorimeter

<table>
<thead>
<tr>
<th>Sample</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>873</td>
<td>L- 55.16</td>
<td>L- 53.70</td>
<td>L- 54.15</td>
</tr>
<tr>
<td></td>
<td>a- 6.22</td>
<td>a- 6.88</td>
<td>a- 7.23</td>
</tr>
<tr>
<td></td>
<td>b- 18.78</td>
<td>b-18.17</td>
<td>b- 19.40</td>
</tr>
<tr>
<td>204</td>
<td>L-49.50</td>
<td>L-44.31</td>
<td>L-48.38</td>
</tr>
<tr>
<td></td>
<td>a- 6.07</td>
<td>a- 6.66</td>
<td>a- 5.83</td>
</tr>
<tr>
<td></td>
<td>b- 16.02</td>
<td>b-16.10</td>
<td>b- 15.62</td>
</tr>
<tr>
<td>985</td>
<td>L-40.92</td>
<td>L-47.53</td>
<td>L-44.27</td>
</tr>
<tr>
<td></td>
<td>a- 6.26</td>
<td>a- 7.09</td>
<td>a- 6.21</td>
</tr>
<tr>
<td></td>
<td>b- 14.31</td>
<td>b-16.81</td>
<td>b- 14.97</td>
</tr>
</tbody>
</table>

**Table 3:** Ranking of each sample in regards to taste by the sensory panel. 1 being the best taste and 3 being the worst taste

<table>
<thead>
<tr>
<th>Sample</th>
<th># ranking 1st</th>
<th># ranking 2nd</th>
<th># ranking 3rd</th>
</tr>
</thead>
<tbody>
<tr>
<td>873</td>
<td>9</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>204</td>
<td>1</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>985</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>
Figure 1: Grams of force as measured by the Texture Analyzer for each sample for each trial.
Figure 2: L-value (Lightness/Darkness) for each sample for each trial as measured by the Hunter Colorimeter
Figure 3: a-value for each sample for each trial as measured by the Hunter Colorimeter
Figure 4: b-value of each sample for each trial as measured by the Hunter Colorimeter
**Figure 5:** Ranking of taste of each sample by participants: 1 being the best taste and 3 being the worst taste.

### VII. References


Sensory Evaluation

Please Indicate the Tenderness and Taste of each sample on the following scales:

204

Very Tough

Dislike Very Much

Very Tender

Like Very Much

873

Very Tough

Dislike Very Much

Very Tender

Like Very Much

985

Very Tough

Dislike Very Much

Very Tender

Like Very Much

Please rank the samples from 1 to 3 on taste preference; 1 being the sample that tasted the best and 3 being the sample that tasted the worst.

____204

____873

____985

Please write any comments below: