The effects of substitution of all purpose, whole wheat flour, and spelt flour on product quality in the baking of apple muffins

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Abstract:

The purpose of this research was to determine if the different flours product used in the preparation of muffins would affect the quality, texture and taste and appearance in muffins. The idea of substituting all-purpose flour with spelt and whole wheat flour in preparation to Betty Crocker’s apple muffin and analyzing how different flours affects the overall quality of the muffin, and which muffin contains the most valuable appearance, texture, moistness and flavor with respect to the quality. The experiment was preformed three times to improve the results. A texture analyzer was used to measure the texture, flavor, appearance, taste was conducted subjectively by a taste-test panelist and the increase in volume was measured by using calipers. Overall, the spelt flour had the best results ranking number first in flavor, appearance, texture, and moistness. The second best ranking was followed by whole wheat flour and all-purpose had the poor results. So based on the findings of the objective and subjective tests, the product should be developed based on consume appeal.

Introduction:

Referring to the article, “Grains of truth about wheat flour,” “flour is the product obtained by grinding wheat kernels or “berries.” The kernel consists of three distinct parts: bran, the outer covering of the grain; germ, the embryo contained inside the kernel and the part of the kernel that makes white flour. So, during milling, the three parts are separated and recombined accordingly to achieve different types of flours”. The basic purpose of flour in baking is that it contributes body and structure, texture and flavor to baked goods. It binds the ingredients together and supports the batter. Flour can be used in different areas such as; thicken sauces, creams and pie fillings etc. The type of flour used in the product will ultimately affect the final finished product. Flour type is important in determining gluten development, flavor, and texture. Flour contains proteins and when it comes in contact with water and heat it produces gluten which gives elasticity and strength to baked goods. Different types of flour contain different amounts of protein. Therefore using a different type of flour will alter the outcome of the baked good.
According to Pat Beck, Nutrition specialist, he said that “all-purpose flour is the wheat kernel’s finely ground endosperm, which is separated from the bran and germ during the milling process. All-purpose flour is made from hard wheat’s or a combination of soft and hard wheat’s. With it the home baker can make a complete range of delicious baked products such as yeast breads, cakes and cookies, pastries and noodles to name a few. This flour should be enriched and may be bleached or unbleached. Whole wheat or graham flour is coarse textured flour ground from the entire wheat kernel. It contains the bran, germ and endosperm. The presence of bran and the germ reduces gluten development. Baked products made from all whole wheat flour tend to be heavier and denser”. It is made from the entire what grain and additives, for added nutrients. Graham flour is readily available and is used instead of whole wheat flour. Graham flour is basically the same as whole wheat flour, but the exact blend depends on the company (Goober, 1985). Whole wheat flour is 12.6% protein (Kent, 1994). According to Walton’s website (http://waltonfeed.com/self/spelt.html) it’s being quoted that “spelt contains 15 - 21% protein which is much higher than wheat. It's also higher than wheat in complex carbohydrates, iron, potassium and the B Vitamins. Spelt is easier to digest than wheat products because of its higher solubility in water. Spelt also contains nutrients that aid in blood clotting and also stimulate the immune system. Due to Smelt’s high water solubility and fragile gluten, the grain's vital substances can be absorbed quickly by the body with a minimum of digestive work. Spelt contains special carbohydrates which play a decisive role in blood clotting and stimulate the body's immune system. Its high fiber content aids in reducing cholesterol and heart disease.”

Other ingredients include salt, baking powder and milk. Salt acts as a flavor enhancer and toughens gluten which leads to a less sticky dough (Kent, 1994). By using different flours listed above, the purpose of this project was to see the difference in moisture content, texture, appearance and flavor. Baking powder acts as leavening agent and milk is the key component in gluten development that holds the dough together. The Betty Crocker’s apple muffin was made from all-purpose flour, whole wheat and spelt flour, to determine that which flour gives the highest quality finished product.
Experimental Methods:

Materials:
Ingredients needed for the experiment include: three types of flour (spelt and whole wheat 130 grams and all-purpose 116 grams), 2 large eggs, 6.6 grams of baking powder, 68 grams of chopped raw red delicious apple and 84 ml of 2% milk, muffin pans a total of 18 cups; three bowls for mixing, electric mixer; and an oven operating at the temperature of 400 degrees Fahrenheit.

Preparation Procedure
Each muffin mix was prepared separately using appropriate amount of ingredients like eggs, milk, salts and baking powder for each mix. After the contents have been placed in the bowl, they are mixed until slightly lumpy. 116 grams of all-purpose flour was mixed with given ingredients, 130 grams of whole wheat flour and spelt flour was mixed with similar amount of ingredients followed in all-purpose flour. The 6 muffin were marked accordingly to which product was used. The pans were labeled, specifying the product used along with the bags that muffins were stored in. The muffins were placed in the oven for approximately 18 minutes (until it was golden brown) at 400 degrees Fahrenheit.

Subjective Tests (Sensory evaluation)
After the muffins had cooled, a sensory evaluation of the muffins was conducted using at least 15-20 untrained panelists who completed the muffin sampling form (figure 1). Each sample was numbered as follows; all-purpose flour as 618, whole wheat flour as 339, and spelt flour as 586. The panelist rated all three samples on a scale of 1-9, 1 being least like in flavor, texture, appearance and moistness and 9 being the most like in flavor, texture, appearance and moistness. Once, the panelists were done with rating then it was total and averaged it and then recorded (shown in table 1).
**Objective tests**

**Texture Analyzer / Calipers**

When the muffins were completely done in the oven, they were cooled in room temperature for approximately 5-8 minutes before any tests were run. For the objective analysis, two muffins were taken from each batch and the texture analyzer and calipers were applied to the muffin. The texture analyzer was done to evaluate the tenderness of each muffin by using the puncture probe (Figure 1). For calipers was done to measure the increase in volume between batter and finished product. Figure 2 tells by how much the product rise. 

**All these testing were conducted three times in the laboratory to improve and justify the results.**

**Results:**

The measurements of relative quality of the muffins made from all-purpose, whole wheat and spelt flour differed from trial 1 to trial 2 in that the muffins made in trial 1 was slightly uncooked. This was due to not much longer cook time or the mixing was not properly uniformed so this caused the muffins to baked for longer period of time (instead of 18 minutes, it was over 20-22 minutes).

In figure 1, this data shows the relevance of different flours in muffins. The force that was used in the spelt flour muffins exhibited the lowest of the three products used in the muffin experimentation. The muffin evaluated by the panelist described spelt flour as a high quality finished product (Table 1). I hypothesize that whole grains such as spelt and whole wheat flour will give a fuller flavor to muffins as well as increase their fiber content and nutritional value. Because of naturally occurring oils that are contained in the germ portion of whole grains, they will also increase the moistness of the final product. However, all-purpose flour will produce a finer texture (due to smaller particle size). Whole Wheat flour generally gives more volume increase and stability to the finished product than does spelt flour. The substitution of whole wheat, and spelt flours for all-purpose flour in muffins which will alter the moistness, texture, amount of rising, and flavor of the quick bread while at the same time preserving the essential properties of
a satisfactory finished product. My assumption was concluded wrong are further tests may need to be conducted to examine the reasoning. I believe that this kind of error may be due to the mixture was not beaten longer to insure better gluten development or over kneading is a possibility because of the lower protein content. According to Jozes Kokini, chairman of the food sciences department at Rutgers University's Cook College in New Brunswick, said “The more protein flour has the more gluten it will produce when it's kneaded. And the more gluten you have the less tender your baked goods will be.” Referring to Jozes Kokini all-purpose flour contains about 10-12% protein, and spelt contain 8-11% protein. When two flours are compared all-purpose has the highest protein content which means it should have produce highest quality finished product but in this case spelt had the highest quality finished product. It was symmetrical, with an evenly browned crust. It was fine in texture with no large air bubbles. The crumb was moist, soft and tender and had a fresh tempting apple aroma.

Table 1, displays the sensory evaluation of the Betty Crocker’s apple muffin prepared from different flour mentioned in Table 1 showed significant differences. The total pooled scores obtained by the various treatments of flour for appearance, flavor, texture, and moistness were (# 618) 6.0, 5.9, 5.3, 5.3, (#339) 6.7, 7.1, 5.9 and 6.3, and (#586) 8.6, 6.4, 7.5 and 8.4 respectively. These results revealed that muffins made from spelt flour were ranked at the top followed by whole wheat flour and the all-purpose flour. During the sensory evaluation was done by panelist, they personally liked the muffins made from spelt flour due to its delicious flavor, and soft textured.

Table 3 displays the average muffin heights after baking. It indicates that muffin made with spelt flour had higher amount of increase in volume compared to the ones made with whole wheat and all-purpose flour. As previously discussed, I hypothesized opposite of this again my explanation is related to the protein content and gluten development during kneading or mixing. There reason might be that since in whole wheat flour, the proteins were more dilute due to extra weight of the bran present in the flour which decreases the volume generated during gluten development and baking. The decreased volume of the
wheat dough caused the dough to be stiffer, observed during kneading and the muffins heavier and denser.

Figure 3, is the overall results of the quality of the muffins. The most favored flavor, appearance, texture and moistness of muffins was the substituting spelt flour for all-purpose flour. Muffins prepared with all-purpose flour were ranked as the worst in appearance, flavor, texture and moistness. This could be due to the over/under kneading, or the flour might have being old as compared to whole wheat or spelt flour.

The main reason for obtaining not very accurate results could vary due to the mixing of the batter, the equal distribution of dry ingredients and liquid ingredients within the mix and the measurement of muffin mix per muffin. These are all contributing factors of gluten development in the muffins. So, alternative methods of resolving the inverse relationship between three flours need to be investigated. A possible solution would be exact kneading and strokes should apply while making the muffins. For this more tests needed to be run to determine whether the spelt or whole wheat produces high volume and which one has finer texture. Overall, the muffins made with spelt flour received the best ratings considering the three traits.

**Conclusion:**
Whole wheat flour produced a muffin that was higher than the others in terms of strength or stiffness but the spelt flour was preferred by the sensory panelist. So it can be concluded that various flour type significantly affect the muffins texture, appearance, and flavor when using variation of flour. Overall, the muffins that were made from spelt flour did exhibit the highest volume, the best flavor, the most preferred muffin and overall appearance is rated first. This was seen in all three trails. So for this reason, the trials were consistent throughout the experiment that leads to the assumption that the results were accurate.

In conclusion, the results showed significant differences in various flour types. Further research is needed to develop the basic idea of an apple muffin into a sensory acceptable product with the characteristics tender, moist and mouthfeel taste to consumer.
The Effect of Different Types of Flour on Muffin Quality

(Rate the four samples on a scale of 1 to 9 -- 1 being least visually pleasing, least flavorful, toughest, and driest, and 9 being most visually pleasing, most flavorful, most tender, and most moist.)

Table 1

<table>
<thead>
<tr>
<th>Variable Number</th>
<th>Appearance</th>
<th>Flavor</th>
<th>Texture</th>
<th>Moistness</th>
</tr>
</thead>
<tbody>
<tr>
<td># 618 All-</td>
<td>6.0</td>
<td>5.9</td>
<td>5.3</td>
<td>5.3</td>
</tr>
<tr>
<td># 339 Whole wheat</td>
<td>6.7</td>
<td>7.1</td>
<td>5.9</td>
<td>6.3</td>
</tr>
<tr>
<td># 586 Spelt</td>
<td>8.6</td>
<td>6.4</td>
<td>7.5</td>
<td>8.4</td>
</tr>
</tbody>
</table>

The Effect of Different Types of Flour on Muffin Quality Texture Averages in Grams of Force As Determined by the Texture Analyzer

Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control All-purpose</th>
<th>Whole Wheat flour</th>
<th>Spelt flour</th>
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<tr>
<td>Average Texture in grams of force</td>
<td>124</td>
<td>139</td>
<td>52</td>
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Average Muffin Heights after Baking

Table 3

<table>
<thead>
<tr>
<th>Variable Number</th>
<th>Heights</th>
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</thead>
<tbody>
<tr>
<td># 618 All-Purpose</td>
<td>4.2 cm</td>
</tr>
<tr>
<td># 339 Whole wheat</td>
<td>4.3 cm</td>
</tr>
<tr>
<td># 586 Spelt</td>
<td>5 cm</td>
</tr>
</tbody>
</table>

Figure 1: Analysis of Texture Measured in Force (g) by a Texture Analyzer in Muffins Prepared with Various Flour
Figure 2: Analysis of Average Muffin Heights (volume) after Baking by Caliper

Figure 3: The Effect of Different Types of Flour on Muffin Quality
Sample Sensory Score Card (1 being dislike to 5 being mostly like)

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Texture</th>
<th>Moistness</th>
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<tbody>
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<td># 618</td>
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<td># 586</td>
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Bibliography:


Dr. Daniel, Jim, Fall 2005. Cereals: Flour and Protein, PDF Handout


Walton’s Website: [http://waltonfeed.com/self/spelt.html](http://waltonfeed.com/self/spelt.html)