**Title:** The effect of replacing cow’s milk with soy or goat’s milk in blueberry muffins on taste and texture.

**Abstract:** Some people are cannot tolerate cow’s milk due to an allergy or lactose intolerance or dislike of the taste. It was hypothesized that using goat’s milk or soy milk in blueberry muffins would result in an equally acceptable product compared with using cow’s milk. The same recipe was used for all three variables, and each batch was mixed and cooked the same. The muffins made with goat’s milk were tenderer compared to the muffins made with soy or cow’s milk. Muffins made with 2% cow’s milk, were the least tender. All variations of muffins rose to the same height. Finally, the taste results from all three trials were averaged, and it was found that people preferred muffins made with goat’s milk. However, the muffins made with cow’s milk were only 0.1 point lower with an average ranking of 5.8 compared to goat’s milk, which had an average ranking of 5.9. Muffins made with soy milk were ranked the lowest, with the average rating being 4.7. However, soy milk can be used for people who are lactose intolerant or are allergic to cow’s milk and performs well in baking.

**Introduction:** For this experiment, goat milk and soy milk were used in place of cow’s milk in blueberry muffins in order to test the acceptability of taste, determine texture and height of muffins. Some people are allergic to cow’s milk and others are lactose intolerant that is they lack enough of the enzyme, lactase, to break down lactose (Swagerty and others 2002). If a person is lactose intolerant, soy milk is generally well tolerated (Swagerty and others 2002). According to [www.silkissoy.com](http://www.silkissoy.com), soy milk can be used in the
same way as regular cow’s milk, such as baked in muffins. Plus, soy has been shown to have many health benefits, such as: reduced osteoporosis, lighter hot flashes, lowering blood cholesterol and a lower occurrence of some cancers (Stauffer 2005). Another benefit of soy milk is that it can be used for patients with cow’s milk allergy due to the small amount of cases of soy milk allergy (Zeiger and others 1999). Goat’s milk is a good source of calcium, phosphorus, riboflavin, potassium and proteins (whfoods.org). In fact, goat’s milk provides more calcium per cup compared to cow’s milk (whfoods.org). Goat’s milk contains lactose, but still might be useful for people who are only mildly lactose intolerant; however, there has been no clinical confirmation to uphold this (Robinson 2001). Some health food and grocery stores claim that goat’s milk can be substituted for people with cow’s milk allergy, but this is only true in some instances (Restani 2004). It has been concluded that goat’s milk is not a suitable substitute for cow’s milk due to broad patient tolerant ranges and severity of the allergic reaction (Restani 2004). Overall, soy milk would be the better choice if there is lactose intolerance or an allergy when compared to cow’s milk or goat’s milk.

Milk is added to recipes to add water, nutrients plus it helps with browning and contributes to product flavor (Lauterbach 1995). The water from the milk helps provide the product with structure and texture (Lauterbach 1995). A recipe for blueberry muffins was used, with the only variable changed being the type of milk. The muffins were mixed for the same amount of strokes, the same amount of batter was placed into the muffin cups, and the muffins were all baked for the same amount of time. The purpose of the experiment was to determine if substituting either goat’s milk or soy milk for cow’s milk in a blueberry muffin recipe would change the texture, flavor or height of the finished product.
The independent variable in this experiment is the milk. It is the variable that is being changed. The dependent variables are: texture, height of muffins, and taste. These are the variables being measured.

**Methods:** The overall design of the experiment was to bake blueberry muffins with different types of milk. The only ingredient changed was the type of milk. The different types of milk used were: 2% cow’s milk, Silk soy milk, and refrigerated goat’s milk. It should be noted that goat’s milk is also available in non-refrigerated forms. The recipe was divided by 1/3 due to the sample size needed, and the recipe in its entirety can be seen in figure 1. First, the oven was heated to 400°F. A 12-cup muffin pan was sprayed with vegetable oil on the bottoms only of the muffin cups. Then 146 grams of Original Bisquick® mix was placed in a medium bowl. Next, 25 grams of sugar, 16.43 grams of egg, 10mL of vegetable oil and 60mL of milk were added to the bowl. All ingredients were stirred for 25 strokes. Then 56 grams of blueberries were added to the batter, and were gently stirred in the batter in 5 strokes. Next, a ¼ cup of batter was poured into a muffin cup. This resulted in 3 muffins for each variable and these steps were repeated for all variables. The muffins were baked for 17 minutes. Then the muffins were then placed into baggies, and the following day texture analysis was done, along with determining the height of muffins and a taste test. Random samples of six people were used to sample the muffins. The majority of the samples were tasted by fellow students. An example of the sensory score card used can be seen in figure 2. The samples were given a random three digit number for each trial. Also, the variable order presented on the plates was changed for each trial. For example, for trial one, the order on the plates were goat’s milk, number 986, then 2% milk, number 582, then soy milk with the number of 784. But for trial three
524 was soy, 653 was goat’s milk, and 137 was 2% milk. The results can be seen in table 1. A toothpick was placed into one muffin from each trial and marked. The toothpick was then placed against a ruler to determine the height of the muffin. The muffins tops were not level, and for each muffin, the tallest portion was measured. Finally, a texture analysis was done to determine the grams of force needed to penetrate the muffin. The texture analyzer used was version 7.13, Load cell 5. It was set on the muffin setting, with a cone probe. The following specific settings were used:

- **Pretest Speed:** 2.0mm/s
- **Test Speed:** 3.0mm/s
- **Post test Speed:** 5.0mm/s
- **Rupture Test Distance:** 1.0mm
- **Distance:** 5.0mm
- **Force:** 2000.0g
- **Time:** 5 seconds
- **Count:** 5 seconds
- **Trigger:** Auto
- **Force:** 4.0g
- **Stop Plot at:** Final
- **Break detect:** off
- **Sensitivity:** 0.0g
- **Units force:** grams
- **Distance:** mm
- **Test Mode and Option**
  - Measure force in compression
  - Return to start

One muffin from each trial underwent texture analysis. The results from the texture analyzer can be seen in table 2.

**Discussion:** To determine which muffin variable was preferred, the rating given to the sample was added up for all responses, then divided by the number of responses to obtain the average. This was done for each trial. Refrigerated goat’s milk was used verses non-refrigerated goat’s milk. According to foodsubs.com, the non-refrigerated goat’s milk can sometimes have a barnyard flavor and that may overpower the product it is used in.
results from all three trials can be seen in tables 1-3. For trial one, the goat’s milk and the
cow’s milk were rated the same, with the average response being 5.8. Soy milk was ranked
lower at 4.8. Results from trial are found in table 1. For trial two, however, cow’s milk and
soy milk had the lowest flavor rating, with an average response of 4.5. Goat’s milk was
ranked the highest with a score of 6.2. This can be seen in table 2. For the third trial, cow’s
milk was ranked the highest at with an average of 7.2, next was the muffins made with
goat’s milk at 5.6 and finally, the soy milk at 4.8. This is shown in table 3. All trials and
variations yielded the almost the exact same size muffin. Since milk contains water, the
water in the muffin vaporizes as it is heated and the steam causes the air cells to expand
which in turn allows the product to rise (Lauterbach and others 1995). The results from
each trial can be seen in tables 4-6. The height in inches varied only slightly, with a range
from 1.8-2.0 inches. One possible reason for the slight height differences may be due to the
location of a blueberry inside the muffin resulting in a slightly taller muffin.

Based on the results form the texture analyzer, the milk that produced the tenderest muffin
was the muffin made from goat milk. Next was the soy muffin, then finally the muffin
made with 2% milk. The results from the individual trials are shown in tables 7-9;
however, the average of each trial was also taken with those results being shown in table
10. Table 9 shows that trial two gave a much higher number compared to trial one and two
for the muffins made with goat’s milk. One possible explanation why the Goat’s milk
appears to be more tender than the other two variations, might be due to the texture
analyzer hitting a blueberry instead of muffin itself. Table 10 shows the average tenderness
for each muffin, with the muffins made with 2% milk being the least tender.
Overall, soy milk was the least liked compared to the other two muffin variations, however, none of the muffins received scores that were very high. Substituting soy milk in muffins for cow’s milk gives a comparable texture and height. However, taste is individualistic, and the person consuming the muffins needs to evaluate the use of soy milk in regard to preference. More research is needed to determine if soy can be used in other products with favorable results. Also, the experiment is limited by the small number of taste panelists.

**Results:**

<table>
<thead>
<tr>
<th>Blueberry Muffins from Betty Crocker</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 cups Original Bisquick® mix</td>
</tr>
<tr>
<td>2/3 cup milk</td>
</tr>
<tr>
<td>1/3 cup sugar</td>
</tr>
<tr>
<td>2 tablespoons vegetable oil</td>
</tr>
<tr>
<td>1 egg</td>
</tr>
<tr>
<td>¾ cup fresh or frozen blueberries</td>
</tr>
</tbody>
</table>

1. Heat oven to 400°F. Place paper baking cup in each of 12 regular-size muffin cups, or grease bottoms only of muffin cups.
2. Stir all ingredients except blueberries just until moistened. Gently stir in blueberries.
3. Divide batter evenly among cups.
4. Bake 13-18 minutes or until golden brown

**Figure 1. Recipe for Blueberry Muffins**

Please rate the flavor of each blueberry muffin using the 9-point hedonic scale with 9 being the most desirable flavor and 1 being the least desirable flavor.

Sample 524
Sample 653
Sample 137

**Figure 2. Sample of Survey using Hedonic Scale**
Table 1. Average response of flavor ranking for trial one.

![Trial One Graph]

Table 2. Average response of flavor ranking for trial two.

![Trial Two Graph]
Table 3. Average response of flavor ranking for trial three.

![Average Response of Flavor Ranking for Trial Three](image)

Table 4. Muffin Height, trial one.

![Muffin Height, Trial One](image)

Table 5. Muffin Height, trial two.

![Muffin Height, Trial Two](image)
Table 6. Muffin Height, trial three

Table 7. Texture Analysis, trial one.
Table 8. Texture Analysis, trial two.

![Bar chart for Texture Analysis, trial two.]

Table 9. Texture Analysis, trial three.

![Bar chart for Texture Analysis, trial three.]

Table 10. Average results, texture analyzer

![Bar chart for Average results, texture analyzer.]
References

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