Effects of Different Types of Sugar on Thickness, Appearance and Viscosity of Cornstarch Pudding

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Effects of Different Types of Sugar on Thickness, Clarity and Viscosity of Cornstarch Pudding

Abstract

Diabetes was the sixth leading cause of death listed on U.S. death certificates in 2002. According to death certificate reports, diabetes contributed to a total of 224,092 deaths. According to National Diabetes Statistics, 20.8 million people suffer from diabetes, and this includes 14.6 million people diagnosed and 6.2 million undiagnosed. Also, diabetes associate with heart disease, high blood pressure, blindness, kidney disease, nerve system disease (National, 2005). Therefore, choosing a right food for diabetic patients is essential. Sugar contributes flavor and appearance to many foods. For example, without sugar, ice cream can be tasteless. However, many people with diabetes have to eliminate all sweeteners from their diet because of the disease. Therefore, finding sugar substitutes can benefit all these people. Fructose used as sugar replacer for many years. It contributes same calories as sucrose, but it dose not increase blood glucose very much as sucrose because it does not need insulin to get into blood cell (Peterson, 2004). The purpose of this experiment was to show that cornstarch pudding made with fructose and glucose had similar quality to sucrose, and improve texture and flavor to cornstarch pudding.

Introduction

Sucrose or table sugar is obtained from sugar cane or sugar beets. It is made from glucose and fructose units. Sucrose has been used for many years, and it is still a major sweetener in people’s daily life. It has been used in many foods such as soft drink, candy, dessert. According to Coulston, MS, RD, People in the U.S. consume sweetener is
increasing every year. Cane and beet sugar increased 22% from 1970 to 1995 (Coulston & Johnson, 2002). However, some diseases are increasing dramatically with people consume more table sugar. according to American Dietetic Association Reports, about 59% of people over consumed total sugars (Position, 2004). Because of health concerns, more and more researchers are interested in finding new sugar substitute, which can be used in diabetic diet and also benefit all population.

Fructose also called levulose, which used as a sucrose substitute in many foods and beverages because of its sweetening power, lower cost, and functional properties that improve flavor, color, and product stability. Fructose is sweeter than granulated sugar and it can be substituted in many recipes with less quantity. Another important function of fructose is that it can be used by diabetes patients. One teaspoon of fructose has about the same number of calories as same amount granulated sugar, but fructose is roughly twice as sweet and tastes particularly sweet when cold or in solution. Many diabetics use it since it doesn't affect their blood sugar as significantly as granulated sugar. The reason is that fructose does not require insulin to get into the liver and body cells (Peterson, 2004).

Glucose is also a monosaccharide. It is also called dextrose produced from high DE syrup by crystallization under controlled cooling and used in the manufacture of candy, jams, jellies, table syrups, and other foods. Glucose tastes only about three-fourths as sweet as table sugar. The objective methods used in this experiment were viscometer and consistometer. The viscometer was used to determine viscosity of pudding, and the values can be used to compare viscosity of different samples. The consistometer was used to verify thickness of the pudding. The subjective methods used were 15 panelists during three trials. Hedonic ranking system was used.
Methods

Recipe: Cornstarch Pudding

(6.6g) 1 Tbsp cornstarch                             (237ml) 1C milk
(0.75g) 1/8 tsp salt                                        (2.5ml) ½ tsp vanilla
(25g) 2 Tbsp sugar

Prepare three sauce pans and three bowls. Use sucrose as the control and label the first bowl with S. Then, label two variables with F and G, which stand for fructose and glucose. Weight each sample. Mix cornstarch, salt, and sugar together in a salad bowl. Add milk gradually while stirring and cooking, stirring occasionally with spoon until thickened. Cover and cook about 5 minutes longer on low temperature. Cool slightly, and then add vanilla for flavor, chill, and serve. To control variables, food sample, temperature, mixing procedure will be set up exactly same. For example, after adding milk, each sample will be given 5 strokes with spoon at same time. Then, cover and cook about 5 minutes. During this period, stirring samples 5 strokes with spoon at every one minute passed. All three sauce pan were set on the stove at medium high. After the samples started to thicken, turn all stove to low heat. Let all pudding samples cool down and add vanilla to each sample. Then, place the sample in refrigerator for about 30 minutes.

9-point hedonic scale, Brookfield viscometer, and consistometer were used to rate overall quality of the pudding. First, sensory evaluation was done by different group of people at each trial. First labeled three samples with V.1, V.2, V.3, and let panelists tasted sample and rate each sample with hedonic scale on thickness, appearance, flavor, and sweetness. 9 = extremely thick, very good appearance, very good flavor, extremely
sweet, and 1 = extremely thin, very poor appearance, very bad flavor, extremely unsweet. Then set up Brookfield viscometer to analyze viscosity of the samples. First, attach spindle to lower shaft, and lower clutch and place in spindle in the sample. Check the fluid level, which is at the immersion groove cut in the spindle shaft. Turn the SPEED/SPINDLE switch in the left position and turn control knob to 100 rpm and adjust spindle to S06. Turn on the motor switch. Start the viscometer and record the data. Next use consistometer (Bostwick) to measure consistency of the samples. First, set the consistometer on a table and check if the bubble in the spirit level is centered. Close the gate and fill the reservoir with the sample. Push down the trigger to open the gate and record the time of flow (Weaver & Daniel 2004).

Discussion

During the procedure, variable 2, fructose, thicken first, which took 4 minutes to thicken. Sucrose took 7 minutes to thicken, and variable 1, glucose, took 12 minutes to thicken. Sucrose provided high quality of cornstarch pudding. Fructose gave sweetest and thickest pudding among the others, but it appeared darker than others. The rating score and difference were shown in table 1 and fig1. According to sensory evaluation by using hedonic scale, the average score for control was 7.18, variable 1 (fructose) was 7.10, and variable 2 (glucose) was 5.35. The overall results showed the control (sucrose) had the highest rating, and the rate for fructose was much closed to sucrose. The average result for three samples was shown in Fig2. Table 2 showed that the average result from viscometer was 100 for sucrose, 293 for fructose, and 123 for glucose. The results showed that fructose had highest viscosity, and sucrose had lowest viscosity. The results for each sample obtained from viscometer in three trials were very similar as shown in
The average values for consistometer were 13.4, 4.67, and 12.5, which means that fructose was thickest among the other samples, and sucrose was thinnest. The difference can be easily seen from fig4. Glucose provides similar appearance to cornstarch pudding, but the pudding does not taste as good as the pudding made with sucrose and fructose. Also, it is less sweet than other samples.

During the experiment, some factors may affect starch paste viscosity and gel strength. First, stirring can affect the quality of pudding. Too much stirring cause granules broke apart. Another factor is cooling and storage conditions. Research has found that the cooling conditions will impact the strength of the pudding. If pudding is cooled too fast, amylase will not have time to form the vital micelles necessary for the three dimensional structure. If cooled too slowly, the amyllose fractions will have a chance to align too much and become too close together and the liquid portion will not be trapped in the micelles (Evageliou, Richardson, & Morris, 1999). Also, sugar affects the gelatinization of starch. Research has shown that sugar will delay or inhibit gelatinization of starch. The starch pudding may be less viscose or have a less firm gel. However, there have been a number of researchers that indicate that sugar actually interacts with the amorphous areas of the starch granules (Genovese, Acquarone, Youn, & Rao, 2004). Also, milk is very easily to scorch during the experiment and make undesirable color. By using double boiler may reduce the problem.

Texture, appearance and flavor are important factors for food. More and more researchers try to find substitutes and replacers to improve quality of product according different chemical structure, properties, and characteristics of sugar. Different sugar types provide different chemical structure, which influence the way the food behaves under
different processing and preparation conditions. Similar experiments were done by many other researchers. Since the 1950s, the effects of sucrose, glucose, and fructose on 5% cornstarch paste were studied. Sugar affects the gelatinization of starch, such as a starch pudding. Research has shown that sugar will delay gelatinization of starch. The starch pudding may have a less firm gel. The type of sugar also influences the degree of gelatinization. In addition, the type of sugar affects the thickness, clarity, and viscosity of final product. Researchers indicate that it is likely due to the competition for water. Fructose compete more water than sucrose, so the pudding made with fructose appears darker than the one made with sucrose and glucose. Different sugars on gelatinization of 5% cornstarch significantly influenced the quality of product. The experiment showed fructose had highest viscosity and shortest time to thicken, and sucrose had lowest viscosity and longest time to form a gel (Evageliou, Richardson, & Morris, 1999).

Among three sensory characteristics, texture, color and flavor, flavor can be the most important one to be focused on. From the results of the experiment, the pudding made with glucose had poor flavor, even though it had similar appearance with the one made with sucrose. Also, glucose provides calories and is easily absorbed into blood cells to increase blood sugar level. Therefore, glucose is not a good substitute for sucrose. Fructose gave overall good quality of cornstarch pudding. It enhanced texture and sweetness of pudding. Although appearance of pudding was not as good as other samples, it provided comparable flavor with sucrose and also contribute health benefit to people. As the result, fructose can be considered as a sugar substitute in cornstarch pudding.
Results:

Table 1: Average result for sensory evaluation on sugar type on corn starch pudding

<table>
<thead>
<tr>
<th>Variables</th>
<th>Thickness</th>
<th>Appearance</th>
<th>Flavor</th>
<th>Sweetness</th>
<th>Total average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucrose</td>
<td>5.6</td>
<td>8.8</td>
<td>7.4</td>
<td>6.9</td>
<td>7.18</td>
</tr>
<tr>
<td>Fructose</td>
<td>8.2</td>
<td>5.1</td>
<td>7.0</td>
<td>8.1</td>
<td>7.10</td>
</tr>
<tr>
<td>Glucose</td>
<td>5.2</td>
<td>6.2</td>
<td>4.4</td>
<td>5.6</td>
<td>5.35</td>
</tr>
</tbody>
</table>

Compare cornstarch pudding by rating on a hedonic scale, with 9=extremely thick, very good appearance, excellent flavor, and extremely sweet, and 1=extremely thin, very bad appearance, and bad flavor.

Table 2: Measuring viscosity by viscometer (g/cm)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Trial I</th>
<th>Trial II</th>
<th>Trial III</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucrose</td>
<td>100</td>
<td>90</td>
<td>110</td>
<td>100</td>
</tr>
<tr>
<td>Fructose</td>
<td>280</td>
<td>300</td>
<td>300</td>
<td>293</td>
</tr>
<tr>
<td>Glucose</td>
<td>130</td>
<td>110</td>
<td>130</td>
<td>123</td>
</tr>
</tbody>
</table>

Table 3: Measuring thickness by consistometer (cm)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Trial I</th>
<th>Trial II</th>
<th>Trial III</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucrose</td>
<td>13.5</td>
<td>13.5</td>
<td>13.25</td>
<td>13.4</td>
</tr>
<tr>
<td>Fructose</td>
<td>5.0</td>
<td>4.75</td>
<td>4.25</td>
<td>4.67</td>
</tr>
<tr>
<td>Glucose</td>
<td>13.25</td>
<td>12</td>
<td>12.25</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Hedonic Scale Results

Fig 1: Hedonic evaluation of sucrose, fructose, and glucose
**Average Hedonic Evaluation**

![Bar graph showing average hedonic evaluation of three samples](image1)

*Fig2. Average hedonic evaluation of three samples*

**Viscometer Results**

![Line graph showing viscometer results](image2)

*Fig3. Values from Brookfield viscometer*

**Consistometer Results**

![Bar graph showing consistometer results](image3)

*Fig4. Values from consistometer*
Reference


