### STEM in Food Science in Technology and Living

**Laboratory Manual**

Table of Contents

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Topic | | Food Test | | Page No. |
| Starches in Food | Gelatinsation of Starch | 1 | Making of blueberry sauce | 1 |
| 2 | Observe gelatinisation of starch by adding hot water | 3 |
| Proteins | Foaming of Protein | 3 | Making of marshmallow | 4 |
| Coagulation of Protein | 4 | Factors affecting egg coagulation | 7 |
| Effects of Heat on Protein | 5 | Effects of heating temperature on egg doneness | 9 |
| Fruits & Vegetables | Enzymatic Browning of Fresh Fruits | 6 | Browning reactions in apples | 11 |
| Effects of pH Condition on Green Vegetables | 7 | Heating of green vegetables | 13 |
| Maillard Reaction | 8 | Maillard reaction in onions | 15 |
| Flours and Flour Mixtures | Functions of Raising Agents | 9 | Observe the reaction of biological and chemical raising agents in water | 17 |
| 10 | Functions of different raising agents in muffins | 19 |
| Effects on Sugar on the Quality of Sponge Cake | 11 | Effects on sponge cake with different amounts of sugar | 22 |
| Effects of Salt on the Quality of Bread Dough | 12 | Effects on bread dough with different amounts of salt | 25 |
| Functions of Egg in Flour Mixture | 13 | Effects on pound cake with different amounts of egg | 27 |
| Sugars | Caramelisation | 14 | Caramelisation of sucrose and fructose | 29 |
| Molecular Gastronomy (Physical and chemical reactions during cooking) | Transforming a Liquid into Solid by Hydrocolloids | 15 | Making of soya milk spaghetti | 31 |
| Dehydration of Oil by Maltodextirn | 16 | Making of olive oil powder | 33 |
| Spherification | 17 | Making of coffee caviar | 34 |

**Gelatinisation of Starch**

**Objective**

To investigate the gelatinisation of starch.

**Principles**

Gelatinisation is a disruption of the orderliness of starch granules and the swelling of these granules. It occurs when large amounts of water move into the granules, separating and surrounding starch molecules, pushing them apart. Since water is trapped by gelatinised starch molecules, it cannot move freely. Likewise, the swollen starch granules cannot move freely, because they are pressed against each other. With nothing moving, the starch mixture is thickened. As heating continues, the granules continue to swell and starch molecules, especially smaller amylose molecules, leach out of the granules and into the hot liquid.

Cereal starches are extracted from the endosperm of cereal grains. Cornflour, for example, is purified from the endosperm of corn kernels. Other cereal starches included rice starch, wheat starch, and waxy maize.

Root starches are extracted from various root or tuber plants. Potato starch, arrowroot, and tapioca are examples of root starches.

***Food Test 1***

*Making of blueberry sauce*

**Objective**

To investigate the gelatinisation effects of cornflour with blueberry sauce.

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Blender  Sieve  Saucepan x 2  Scale  Measuring jug  Labels  Whisk  Timer  Spatula  Spoon x 2  Bowl x 2 | |  |  |  | | --- | --- | --- | |  | Sample A | Sample B | | Blueberry | 25 g | 25 g | | Water | 100 ml | 100 ml | | Cornflour | -- | 5 g | |

**Procedures**

Blend blueberry and water together.

1. Sieve to remove pomace.
2. Heat juice in a saucepan over medium heat. Stir gently and bring to the boil.
3. Sample A

* Heat for 2 more minutes.

1. Sample B

* Stir in cornflour and continue to heat for 2 more minutes.

1. Remove from heat, and transfer to a bowl.
2. Observe.

**Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sample** | **Addition of Starch?** | **Colour** | **Shininess** | **Viscosity** | **Other observations** |
| A | No |  |  |  |  |
| B | Yes, cornstarch |  |  |  |  |

**Questions**

1. Which sample is thicker in texture?
2. What is the function of cornflour?
3. How can cornflour be used in cooking?

***Food Test 2***

*Gelatinisation of different types of starch (wheat flour, rice flour, tang flour and glutinous rice flour)*

**Objective**

To observe gelatinisation of starch by adding hot water.

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Mixing bowl x 4  Measuring jug  Scale  Labels  Chopsticks x 4 pairs / Wooden rolling pins x 4 | Sample A Wheat flour 40 g  Sample B Rice flour 40 g  Sample C Tang flour 40 g  Sample D Glutinous rice flour 40 g  Boiling water 80 ml x 4 |

**Procedures**

1. In each bowl, place one type of starch. Label.
2. Pour in boiling water.
3. Stir vigorously.
4. Observe.

**Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sample** | **Type of starch** | **Clarity** | **Viscosity** | **Stringy texture** | **Other observations** |
| A | Wheat flour |  |  |  |  |
| B | Rice flour |  |  |  |  |
| C | Tang flour |  |  |  |  |
| D | Glutinous rice flour |  |  |  |  |

**Questions**

1. If clarity is important, which starch is the best choice for thickening?
2. Which starch is most likely to provide a chewy texture?
3. Which starch is most likely to provide a firm texture?

**Foaming of Protein**

**Objective**

To investigate the foaming ability of protein.

**Principles**

Many physical and chemical properties of food components alter food quality including the texture and the colour of the food. Understanding those properties help in developing new food products and improving food quality.

Foam consists of gaseous (air) dispersed phase and aqueous continuous phase. Foaming is one of the major techniques in making marshmallow. Foam is formed by beating protein.

Denaturing a protein is to apply energy to break the hydrogen bonds holding the protein together. The hydrophobic regions of the unraveled protein tend to stick together (coagulation). Aggressive agitation that introduces large amounts of air into protein mixture (foaming) can also denature protein. During beating, the protein will stiffen into a white foamy semisolid. This stiffening and change of colour from clear to white can also seen in heat denaturation of egg white protein. The denatured protein coagulates and trap air bubbles. The large amounts of trapped air bubbles give the coagulated protein matrix a soft, semi-solid texture.

***Food Test 3***

*Making of marshmallow*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Bowl  Mixing bowl (medium)  Electric mixer  Measuring jug  Measuring spoons  Baking tin  Baking paper  Saucepan  Sieve  Scale  Dough cutter | (Refer to the recipe for ingredients) |

**Procedures**

1. Make marshmallow.
2. Observe while beating.
3. Let it set for at least 6 hours (or until next day). Cut open and observe.

**Results**

|  |  |
| --- | --- |
| Describe the following attributes of gelatine during beating: | |
| Colour |  |
| Shininess |  |
| Texture |  |
| Describe the following attributes of marshmallow after setting: | |
| Colour |  |
| Texture |  |
| Mouthfeel |  |

**Questions**

1. What causes the colour change of gelatin during beating?
2. What is inside foam?
3. What other ingredient(s) can foaming perform on?

**Recipe: Marshmallow (Food Test 3)**

**Ingredients**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Dusting* |  |  | *Syrup* | |
| Icing sugar | 36 g |  | Castor sugar | 60 g |
| Cornflour | 36 g |  | Light corn syrup | 160 g (125 ml)\* |
| *Protein component* |  |  | Salt | ¼ tsp |
| Gelatin | 10 g |  | Water | 60 ml |
| Cold water | 60 ml |  | *Flavouring* |  |
|  |  |  | Vanilla essence | Few drops |
|  |  |  | \* Suggest to measure 160 g of syrup directly into saucepan to prevent handling loss. | |

**Preparation**

1. Line baking tin with baking paper.
2. Combine icing sugar and cornflour for dusting.
3. Dust about ¼ of icing sugar mixture on baking paper.
4. Mix gelatin and cold water in a mixing bowl.

**Procedures**

1. Combine all Syrup ingredients in a saucepan. Heat over medium high heat until 110-115oC. Remove from heat.
2. Beat the gelatin mixture at low speed.
3. Slowly pour the heated syrup into gelatin mixture.
4. Turn electric mixer to high speed and continue to beat for 10 minutes or until mixture becomes very thick.
5. Add vanilla essence and beat well.
6. Pour the mixture into lined tin.
7. Dust the surface with ¼ of icing sugar mixture.
8. Let stand for at least 6 hours or overnight.
9. Transfer the marshmallow on a cutting board. Cut into pieces and dust with remaining sugar mixture.

Coagulation of Protein

**Objective**

To investigate the effects of added ingredients on egg coagulation.

**Principles**

When eggs are heated, proteins in both egg white and egg yolk will denature. The protein will then be unfolded and aggregate with each other. This process is known as protein coagulation. Egg custard is thickened by the heat coagulation of egg protein. However, the more eggs are heated, the aggregated network will become rigid and eventually lead to over-coagulate and shrink. Over-coagulation will affect the texture and appearance of the egg custard. Therefore it is essential to add other ingredients in addition to egg for slowing down the coagulation.

***Food Test 4***

*Factors affecting egg coagulation*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Bowl x 3  Measuring jug  Steaming rack  Wok  Whisk  Aluminium foil sheets x 4  Sieve  Scale  Bowl (big) x 4  Mixing bowl | Eggs 4   |  |  | | --- | --- | |  | Additional ingredients | | Sample A | Nil | | Sample B | ½ Tbsp sugar | | Sample C | 50 ml water | | Sample D | 50 ml whipping cream | |

**Procedures**

1. Beat 4 eggs in 4 different bowls.
2. Add corresponding additional ingredients to each bowl.
3. Mix well.
4. Remove the bubbles on top.
5. Cover each bowl with aluminum foil.
6. Steam over medium high heat for 12 minutes.

**Results**

|  |  |  |
| --- | --- | --- |
|  | **Appearance** | **Texture** |
| Sample A |  |  |
| Sample B |  |  |
| Sample C |  |  |
| Sample D |  |  |

**Questions**

1. Which sample has the most curdling?
2. What are the functions of sugar and fat in egg custard?
3. Why dilution of egg can prevent over-coagulation?
4. What may happen if milk is used to make the steamed egg custard instead of cream?
5. Rank the parts of the egg (whites, yolk, whole egg) from lowest to highest in the rate of coagulation and the tendency to over-coagulate.

Effects of Heat on Protein

**Objective**

To investigate the textural change of egg upon heating with different temperature.

**Principles**

Heating causes egg white and egg yolk to become hard and firm. Egg white and egg yolk each contains proteins which coagulate or harden at different temperatures.

Egg white contains many different proteins, and they coagulate within a very wide range of temperature. In general, egg white proteins start to coagulate at around 60oC, some proteins coagulate at up to 80oC. Egg yolk begins to thicken around 65oC and sets around 70oC.

***Food Test 5***

*Effects of heating temperature on egg doneness*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Water bath | Whole egg 3   |  |  |  | | --- | --- | --- | |  | Water temperature | Heating time | | Sample A | 60oC | 60 minutes | | Sample B | 65oC | 60 minutes | | Sample C | 70oC | 60 minutes | |

**Procedures**

1. Preheat water bath to designated temperature.
2. Submerge egg under water for the designated heating time.
3. Rinse egg under cold running water.
4. Open eggs and compare results.

**Results**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Texture of egg white** | **Texture of egg yolk** | **Any liquid observed?** | **Other observations** |
| Sample A |  |  |  |  |
| Sample B |  |  |  |  |
| Sample C |  |  |  |  |

**Questions**

1. Which sample shows most coagulation?
2. Why is egg white and egg yolk of Sample B the way it is?
3. How does the texture of a soft-boiled egg compare to the samples?

Enzymatic Browning of Fresh Fruits

**Objective**

To investigate the effects of refrigeration, cold water, salt, lemon juice, and blanching on the colour retention of fruits.

**Principles**

Enzymatic browning is a chemical process which occurs in vegetables and fruits. The colour change is due to the oxidation of phenolic compounds into a brown pigment. Browning reactions can be minimised by deactivating the enzyme and reducing oxidation.

***Food Test 6***

*Browning reactions in apples*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Cookie cutter  Small bowl x 6  Food wrap  Measuring spoon  Knife  Saucepan  Ice cube  Labels | Apple, red delicious 1   |  |  | | --- | --- | |  | Medium / condition | | Sample A | Air | | Sample B | Food wrap + Refrigeration | | Sample C | Distilled water 30 ml | | Sample D | Distilled water 30 ml + Salt ½ tsp | | Sample E | Lemon juice 1 tsp | | Sample F | Blanched (simmer in water for 2 minutes + soak in ice water for 2 minutes) | |

**Procedures**

1. Cut the apple into 6 equal pieces.
2. Put slices of apples in bowls with corresponding medium / condition.
3. Let stand for 60 minutes.
4. Observe the colour changes.

**Results**

|  |  |
| --- | --- |
|  | **Colour of apples** |
| Sample A |  |
| Sample B |  |
| Sample C |  |
| Sample D |  |
| Sample E |  |
| Sample F |  |

**Questions**

1. Which sample turns brown the most?
2. Which method may be the best to retain the colour of apples?
3. What are the ways to prepare apples for Fresh Fruit Tartlet and Apple Pie? Why?

Effects of pH Condition on Green Vegetables

**Objective**

To examine the colour and texture changes of boiled green vegetables with different pH conditions.

**Principles**

Chlorophyll stability is affected by pH condition. Heating of vegetables will cause acid in cells to be released to the cooking medium. The acid in the cooking medium convert chlorophyll to pheophytin. The colour of green vegetables then changes from bright green to dull olive brown.

***Food Test 7***

*Heating of green vegetables*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Scale  Saucepan  Measuring jug  Chopsticks x 3 pairs  Small bowls x 2  Plate  Timer | Green vegetables 100 g x 3   |  |  |  | | --- | --- | --- | |  | Cooking Medium | | | Water | Additional ingredients | | Sample A | 800 ml | -- | | Sample B | 800 ml | Baking soda 1 tsp | | Sample C | 800 ml | Vinegar 2 tsp | |

**Procedures**

1. In a saucepan, bring the cooking medium to the boil.
2. Add green vegetables and cook for 3 minutes.
3. Record the colour and texture of cooked vegetables.

**Results**

|  |  |  |
| --- | --- | --- |
| **Cooking medium** | **Colour of cooked vegetables** | **Texture of cooked vegetables** |
| Water only |  |  |
| Water + baking soda |  |  |
| Water + vinegar |  |  |

**Questions**

1. Which cooking medium significantly changes the colour of green vegetables? Explain.
2. Which cooking medium can speed up the breakdown of cellulose and produce a softer texture?
3. What may happen if vegetables are cooked in an alkaline medium for too long?
4. Apart from changing the pH value of cooking medium, what are the ways of preventing acid from the cells to affect the colour of green vegetables?

Maillard Reaction

**Objective**

To examine the effects of pH and temperatures on Maillard reaction.

**Principles**

Maillard reaction is a type of non-enzymatic browning reaction which occurs between reducing sugars and amino groups of proteins when the food is heated. pH and temperature affect the rate of Maillard reaction. Under alkaline condition, reducing sugar contains an aldehyde group of atoms, which is easier to react with amino acid. Whereas in acidic environment, the reducing sugar and amino acid is not ready to react. The higher the temperature, the more water is evaporated, and the faster the reaction.

***Food Test 8***

*Maillard reaction in onions*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Scale  Knife  Measuring jug  Chopping board  Wok chaan  Frying pan | Chopped onion 40 g x 4   |  |  |  | | --- | --- | --- | |  | Medium | | | Water | Additional ingredients | | Sample A | -- | -- | | Sample B | 50 ml | -- | | Sample C | 50 ml | Baking soda ¼ tsp | | Sample D | 50 ml | Vinegar 1 tsp | |

**Procedures**

1. Prepare baking soda and vinegar solution for Samples C and D.
2. Chop and weigh onions.
3. Prepare Sample A and let it expose in the air.
4. Prepare the remaining 3 samples and leave in corresponding medium for 3 minutes.
5. Pat dry gently and heat them in a frying pan for 2 minutes.
6. Observe the colour changes.

**Results**

|  |  |
| --- | --- |
|  | **Colour of onions** |
| Sample A |  |
| Sample B |  |
| Sample C |  |
| Sample D |  |

**Questions**

1. Which medium significantly changes the colour of onion? Explain.
2. Which sample may take the longest time to turn brown? Why?
3. Maillard reaction can be found in the preparation of many dishes. Name two dishes that Maillard reaction could be observed. Explain the reaction in these dishes.

Functions of Raising Agents

**Objective**

To investigate how different types of raising agent (baking powder, baking soda, yeast) work.

**Principles**

Raising agents, also known as leavening agents, cause baked goods to rise, providing lightness and volume. Leavened baked goods are more porous and tender than unleavened, and they are also easier to digest. During baking, heat causes matter to change from one physical form to another, e.g. from liquid to gas. In the process, molecules move faster and spread farther apart. This expansion is the basis for leavening.

There are three main leavening gases in baked goods, steam, air, and carbon dioxide. Steam (water vapour) is the gaseous form of water. It forms when water, milk, eggs, syrups, or any other moisture-containing ingredient is heated. Choux pastry, for example, is leavened almost exclusively by steam. Like steam, air is a physical leavener. Air is added to batters and doughs by physical means--by creaming, whipping, sifting, folding, kneading, and even stirring. Sponge cake and Angel Food Cake contain eggs that are whipped, and this adds volumes of air to the batter. Carbon dioxide is present in air but in trace amounts only. It is formed from two sources: chemical and biological. Baking powder and baking soda (sodium bicarbonate) are chemical raising agents, and yeast is a biological raising agent that can produce carbon dioxide. When carbon dioxide is warmed from the heat of the oven, it moves into existing air bubbles, causing them to expand. Breads and cookies are examples of baked products that rely on carbon dioxide to rise.

***Food Test 9***

*Biological and chemical raising agents in water.*

**Objective**

To observe the reaction of different types of raising agent (baking powder, baking soda, yeast) when warm water is added.

**Principles**

Chemical leaveners break down in the presence of moisture and heat and give off gases.

When baking soda is used for leavening, it is used with acidic materials. Acids react with baking soda in the presence of moisture, carbon dioxide is released as leavening gas. Baking powder contains baking soda, one or more acids (in the form of acid salts), starch or filler, to absorb moisture.

Biological leavening agent – yeasts -- very small single-celled microorganisms. It can break down sugars for energy, this process is called fermentation. Carbon dioxide, alcohol, energy and flavour molecules are the products of fermentation process.

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Glass bowls x 4  Teaspoons x 4  Measuring spoons  Labels  Timer  Thermometer  Saucepan | Sample A Baking powder ½ tsp  Sample B Baking soda ½ tsp  Sample C Yeast ½ tsp  Sample D Yeast + sugar ½ tsp + ½ tsp  Warm water (~40oC) 1 Tbsp x 4 |

**Procedures**

1. Place four samples of raising agents in four separate bowls. Label.
2. Pour water with a gush into the raising agents.
3. Observe.
4. Wait for five minutes. Observe again.

**Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sample** | **Type of raising agent** | **Amount of air bubbles** | **Size of air bubbles** | **What happen in 5 minutes?** | **Other observations** |
| A | Baking powder |  |  |  |  |
| B | Baking soda |  |  |  |  |
| C | Yeast |  |  |  |  |
| D | Yeast + sugar |  |  |  |  |

**Questions**

1. Name a biological leavener that is a source of carbon dioxide.
2. Name a chemical leavener that is a source of carbon dioxide.
3. Which is a source of food for yeast which must be first broken down by enzymes, starch or sugar?

***Food Test 10***

*Functions of different raising agents in muffins*

**Objective**

To investigate how different types of raising agent (baking powder, baking soda, yeast) affect the quality of muffins.

**Principles**

Baking powder and baking soda contain different ingredients and have different pH values. They are applied in different food ingredients. Yeast is a microorganism; carbon dioxide is produced when it ferments. Sufficient time is necessary for fermentation to take place.

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Medium mixing bowls x 4  Sieve  Spatula  Labels  Baking tins  Scale  Paper cases  Electric mixer | Types of raising agents:  Sample A Baking powder  Sample B Baking soda  Sample C Yeast  Sample D Nil  (Refer to the recipe for the amount of raising agent and other ingredients for each sample) |

**Procedures**

1. Prepare 4 muffin samples, three of them with three types of raising agents, one without raising agent. For Sample C, mix yeast into milk instead of sifting it with flour.
2. Compare results.

**Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sample** | **Type of raising agent** | **Shape** | **Texture (Degree of leavening)** | **Taste** | **Other observations** |
| A | Baking powder |  |  |  |  |
| B | Baking soda |  |  |  |  |
| C | Yeast |  |  |  |  |
| D | Nil |  |  |  |  |

**Questions**

1. Do you notice any time difference in the making of Sample C? What causes the time difference?
2. How does texture of Sample C compare to Sample A?
3. How does taste of Sample B compare to Sample A?
4. In Sample D with no raising agent added, what could be present to cause leavening of products?
5. Different raising agents will be used for different products. List the products using baking powder, baking soda and yeast and explain why a particular raising agent is suitable for making the said products.

**Recipe: Muffin (Food Test 10)**

**Ingredients (make 20 muffins)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Batter* |  | |  | **Note:** | ***Types of raising agent*** | |
| Butter | | 216 g |  |  | ***(for experiment)*** | |
| Sugar | | 250 g |  | Sample A | | 20 g baking powder (original |
| Egg yolk | | 4 |  |  | | recipe) |
| Egg white | | 4 |  | Sample B | | 20 g baking soda |
| Baking powder (See Note) | | 20 g |  | Sample C | | 20 g yeast |
| Milk | | 150 ml |  | Sample D | | No raising agent |
| Low gluten flour (cake flour) | | 400 g |  |  | |  |

**Preparation**

1. Pre-heat oven to 180oC.
2. Put paper cases into baking tin.

**Procedures**

1. Beat egg white with electric mixer till foamy. Add half of the sugar separately in three times; beat until soft peak is formed.
2. Cream butter and remaining sugar until light yellow in colour. Add egg yolk and mix well.
3. Sieve flour and raising agent over egg yolk mixture. Stir in milk.
4. Pour the meringue into the batter separately in three times. Mix well.
5. Spoon batter into baking tin.
6. Bake at 180oC for 15-20 minutes.

**Note:** For sample C, mix yeast into milk instead of sifting it with flour.

**Appendix**

***Biological and chemical raising agents in water***

|  |  |  |  |
| --- | --- | --- | --- |
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From left to right: baking powder (Sample A), baking soda (Sample B), yeast (Sample C) and yeast + sugar (Sample D). Pictures of Sample A and B were taken immediately after adding water. Pictures of Sample C and D were taken 5 minutes after adding water.

***Muffins***



|  |  |  |  |
| --- | --- | --- | --- |
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From left to right: Muffins made with baking powder (Sample A), baking soda (Sample B), yeast (Sample C) and no raising agent (Sample D).

**Effects of Sugar on the Quality of Sponge Cake**

**Objective**

To investigate the effects of different amounts of sugar on the quality of sponge cakes.

**Principles**

Sugar has water-retaining nature and increases the volume of baked product. Insufficient sugar will produce a less stable foam. The egg protein will not be elastic and tender. The cake will be less golden in colour, its texture will be less moist and not bouncy. Less tenderness and dryness are observed. As sugar attracts moisture, baked product becomes soft. The more the sugar, the moister the product is.

Excess sugar will elevate the coagulation temperature of the egg protein. This may cause the cake to fall because air will be lost before the crust is formed, the volume will then be lowered. The texture will tend to be gummy and the crust will be excessively browned.

***Food Test 11***

*Effects on sponge cake with different amounts of sugar*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Scale  Mixing bowl (medium) x 5  Electric mixer  Sieve  Whisk  Spatula  Bowl  Cake tin x 5  Baking paper x 5  Oil-absorbing paper x 5 | Amount of sugar:  Sample A 0 g  Sample B 16 g  Sample C 32 g (control)  Sample D 48 g  Sample E 64 g  (Refer to the recipe for the amount of sugar and other ingredients for each sample) |

**Procedures**

1. Prepare the five samples with different amount of sugar according to the recipe.
2. Observe the surface of samples.
3. Cut samples into halves and observe the cross section of each.
4. Compare results.

**Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sample** | **Volume** | **Colour** | **Texture** | **Moistness** | **Other observations** |
| A (0 g) |  |  |  |  |  |
| B (16 g) |  |  |  |  |  |
| C (32 g) |  |  |  |  |  |
| D (48 g) |  |  |  |  |  |
| E (64 g) |  |  |  |  |  |

**Questions**

1. Which sample has the bigger volume?
2. What causes the moistness observed in Sample E?
3. What causes the texture observed in Sample A?
4. Apart from the amount of sugar used, what other factors will affect the colour and texture of sponge cake?

**Recipe: Sponge Cake (Food Test 11)**

**Ingredients (makes a 6-inch cake)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Batter* |  |  | **Note:** | **Amount of sugar** | |
| Egg, beaten | 96 g |  |  | **(for experiment)** | |
| Sugar (See Note) | 32 g |  | Sample A | | 0 g |
| Low gluten flour | 32 g |  | Sample B | | 16 g |
| (cake flour) |  |  | Sample C | | 32 g (control) |
| Butter (melted) | 16 g |  | Sample D  Sample E | | 48 g  64 g |

**Preparation**

1. Pre-heat oven to 170oC.
2. Line cake tin with baking paper.
3. Sieve flour.
4. Melt butter.

**Procedures**

1. In a mixing bowl, beat egg with electric mixer at high speed.
2. Add 1/3 sugar (except Sample A) when foam is seen. Continue to beat.
3. When sugar is dissolved, add another 1/3 of sugar (except Sample A). Continue to beat.
4. When sugar is dissolved, add the remaining 1/3 of sugar (except Sample A). Continue to beat until mixture becomes sticky. The volume should increase by approximately 4 times.
5. Sprinkle sieved flour gradually, and mix with a whisk. Stop when flour is not seen. Do not overmix.
6. Add melted butter and mix well.
7. Gently pour mixture into cake tin.
8. Bake at 170 oC for 15-18 minutes.

Effects of Salt on the Quality of Bread Dough

**Objective**

To investigate the effects of amount of salt on the quality of bread dough.

**Principles**

Small amount of salt is added to flour mixtures for flavouring, producing firmer dough, improving the volume, texture, and evenness of bread crumb structure, and to prolong shelf life. Baked products made without salt tend to be bland. Salt adjusts the solubility and swelling capacity of the gluten, making the dough more pliable, and aiding gluten formation.

In the production of yeast bread, salt helps to control yeast growth. Without salt, fermentation would be too rapid and result in sticky dough. Too much salt would inhibit yeast activity, reducing the amount of carbon dioxide gas produced and decreasing the volume of the loaf.

***Food Test 12***

*Effects on bread dough with different amounts of salt*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Scale  Mixing bowl x 3  Dough cutter  Measuring jug  Food wrap | Amount of salt:  Sample A 0 g  Sample B 5 g (control)  Sample C 10 g  (Refer to the recipe for the amount of salt and other ingredients for each sample) |

**Procedures**

1. Prepare the three samples with different amounts of salt according to the recipe.
2. Proof bread dough for 120 minutes.
3. Observe the appearance of samples.
4. Turn the samples on a flat surface. Touch with fingers.
5. Compare results.

**Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sample** | **Shape of food wrap** | **Volume of bread dough** | **Texture** | **Stickiness** | **Other observations** |
| A (0 g) |  |  |  |  |  |
| B (5 g) |  |  |  |  |  |
| C (10 g) |  |  |  |  |  |

**Questions**

1. Which sample produces most gas?
2. Which sample has the smallest volume?
3. What causes the stickiness observed in Sample A?
4. Apart from reducing the amount of salt in Sample C, what can be done to improve the texture? Why?

**Recipe: Bread Dough (Food Test 12)**

**Ingredients**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Dough* |  |  | **Note:** | **Amount of salt** | |
| High gluten flour | 250 g |  |  | **(for Experiment)** | |
| (bread flour) |  |  | Sample A | | 0 g |
| Oil | 10 g |  | Sample B | | 5 g |
| Sugar | 24 g |  | Sample C | | 10 g |
| Milk powder | 6 g |  |  | |  |
| Salt (See Note) | 5 g |  |  | |  |
| Warm water | 190 ml |  |  | |  |
| Yeast | 3 g |  |  | |  |

**Procedures**

1. Mix flour with oil, sugar, milk powder and salt in a mixing bowl.
2. Sprinkle yeast on top. Pour warm water on top with a gush and mix well.
3. Turn the mixture on a floured table. Knead until dough is elastic and not sticky.
4. Grease the mixing bowl. Return the kneaded dough to the mixing bowl, cover with food wrap.
5. Place the dough in a warm place (not higher than 50oC) for 120 minutes for the first round of proofing to take place.
6. Observe results.

Functions of Egg in Flour Mixture

**Objective**

To investigate the effects of egg on the quality of pound cakes.

**Principles**

The two major constituents of eggs are egg white and egg yolk. Whipping egg white can form foam and trap air. Egg yolk acts as emulsifiers, add flavour, nutrients, and colour to flour mixtures.

Eggs are added to flour mixture to enhance structural integrity. During baking, egg proteins coagulate and cause flour mixture to become firmer.

Eggs also contribute to leavening of flour mixture. Air is incorporated when beating eggs. During baking, trapped air expands and liquid egg turns to steam when heated and the product then expands in volume.

Egg yolks add flavour, nutrients, and colour to products. Yellower crumb and browner crust can be formed. Emulsifier and fat in egg also prevent recrystallisation of starch, hence delay staling.

***Food Test 13***

*Effects on pound cake with different amounts of egg*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Mixing bowl (medium) x 3  Spatula  Electric mixer  Bowls  Labels  Baking tins x 3  Scale  Sieve | Amount of egg:  Sample A 50 ml  Sample B 100 ml (control)  Sample C 150 ml  (Refer to the recipe for the amount of egg and other ingredients for each sample) |

**Procedures**

1. Prepare the three samples with different amount of egg according to the recipe.
2. Observe the surface of samples.
3. Cut samples into halves and observe the cross section of each.
4. Compare results.

**Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sample** | **Appearance** | **Colour** | **Volume** | **Texture** | **Other observations** |
| A (50 ml) |  |  |  |  |  |
| B (100 ml) |  |  |  |  |  |
| C (150 ml) |  |  |  |  |  |

**Questions**

1. Which sample has the biggest volume? Why?
2. What causes the dense and rubbery texture in Sample C?
3. What causes the crumbly texture in Sample A?
4. Apart from changing the amount of egg, what can be done to improve the texture of Sample A and C? Why?

**Recipe: Pound Cake (Food Test 13)**

**Ingredients**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Batter* |  |  | **Note:** | **Amount of egg** | |
| Egg, beaten (See Note) | 100ml |  |  | **(for Experiment)** | |
| Sugar | 75 g |  | Sample A | | 50 ml |
| Low gluten flour | 100 g |  | Sample B | | 100 ml |
| (cake flour) |  |  | Sample C | | 150 ml |
| Butter (softened) | 100 g |  |  | |  |

**Preparation**

* Pre-heat oven to 170oC.

**Procedures**

1. Cream butter and sugar together.
2. Add beaten egg separately in three times. Beat well.
3. Sieve flour into batter. Mix well.
4. Pour batter into baking tin.
5. Bake for 40-45 minutes.

Caramelisation

**Objective**

To examine the temperature for different sugars to caramelise.

**Principles**

Caramelisation is the thermal decomposition of sugar. When sugar is heated, sugar molecules break apart and generate new fragrant molecules and colour. Therefore, heating sugar at high temperatures can form brown caramel pigment with caramel flavour. Different sugars caramelise at different temperatures.

***Food Test 14***

*Caramelisation of sucrose and fructose*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Scale  Saucepan  Thermometer  Timer  Labels | |  |  |  |  | | --- | --- | --- | --- | |  | Sucrose | Fructose | Water | | Sample A | 150 g | -- | 75 ml | | Sample B | -- |  | 75 ml | |

**Procedures**

1. Dissolve sucrose with water in a saucepan.
2. Heat over medium high heat. Stir constantly.
3. Monitor the temperature of syrup regularly with the use of a thermometer.
4. Record the temperature for the initial formation of brown pigment.
5. Continue heating for another one minute.
6. Observe changes in colour and aroma.

Repeat Step 1-6 for fructose.

**Results**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sample** | **Temperature (oC) of initial formation of brown pigment** | **Colour of the final syrup** | **Aroma of the final syrup** |
| A (Sucrose) |  |  |  |
| B (Fructose) |  |  |  |

**Questions**

1. Which sugar forms brown pigment faster?
2. What is the caramelisation temperature for each sugar respectively?
3. What are the application of caramelised syrup in food preparation?
4. Apart from the change in colour and aroma, what other changes can be observed when syrup is caramelised?

Transforming a Liquid into Solid by Hydrocolloids

**Objective**

To investigate the physical transformations of liquid into solid by hydrocolloids upon cooling.

**Principles**

Hydrocolloids, often called gums, are hydrophilic polymers, of vegetable, animal, microbial or synthetic origin, that generally contain many hydroxyl groups and may be polyelectrolytes. They are naturally present or added to control the functional properties of aqueous foodstuffs. Most important amongst these properties are solubility, viscosity (including thickening and gelling), water binding, and many others. Examples of hydrocolloids are carrageenans, alginate, agar, gelatin, pectin, and starch.

Carrageenans are linear polymers of about 25,000 galactose derivatives, and can be prepared by alkaline extraction from red seaweed. Different seaweeds produce different carrageenans. Their functions are mainly thickening, suspending and gelling. Some carrageenans form thermoreversible gels on cooling.

Carrageenan can stabilise milk products by preventing whey separation and is also used as a binder in cooked meats, to firm sausages and as a thickener in toothpaste and puddings.

***Food Test 15***

*Making of soya milk spaghetti*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Scale  Stainless-steel saucepan  Spatula  Funnel  Syringe  Ladle  Tube, 1m in length  Basin | Soya milk 500 ml  Carrageenan 25 g  Ice and cold water |

**Procedures**

1. Insert syringe tip into tube.
2. Prepare a basin of ice water.
3. Heat liquid and carrageenan to around 80oC.
4. Remove from heat.
5. Transfer the liquid to syringe with a funnel.
6. Plunge liquid into long tube. Cool tube in ice water by submerging under water for 2 minutes.
7. Continue plunging to remove content.
8. Observe.

**Results**

|  |  |
| --- | --- |
| What is the consistency of the soya milk before heating? |  |
| What is the consistency of the soya milk after adding carrageenan? |  |
| What is the texture of the spaghetti? |  |
| Any trace of liquid when spaghetti is extruded? |  |

**Questions**

1. Why should liquid be heated?
2. What other ingredient(s) can substitute carrageenan?
3. Other than soya milk, what types of liquid can be used?

Dehydration of Oil by Maltodextrin

**Objective**

To investigate how oil is dehydrated by maltodextrin.

**Principles**

Maltodextrin is a polysaccharide that is used as a food additive. It is produced from starch by partial hydrolysis and appears as very light-weight, white hygroscopic powder.

Maltodextrin can easily dissolve in water with a mildly sweet taste. In manufacturing, spray-drying creates a powder that is very porous on the microscopic level. Because of this structure, maltodextrin is able to soak up fatty substances, making it useful for working with fats when designing food. It absorbs water, so it is used as an emulsifier and thickener, as well as a fat substitute. Once maltodextrin is hydrated, it mimics the viscosity and texture of fats.

***Food Test 16***

*Making of olive oil powder*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Mixing bowl (medium)  Gloves | Maltodextrin 4 g  Olive oil 6 g |

**Procedures**

1. Put olive oil in a mixing bowl.
2. Add maltodextrin bit by bit. Mix with fingers each time after adding until crumbles are formed.
3. Observe.

**Results**

|  |  |
| --- | --- |
| Describe the following attributes of olive oil: |  |
| Texture |  |
| Shape |  |
| Mouthfeel |  |

**Questions**

1. What happens to olive oil powder when it comes in contact with saliva in mouth?
2. What other ingredient(s) can substitute olive oil?

Spherification

**Objective**

To investigate how chemical reactions transform the physical properties of food.

**Principles**

Alginates are refined from brown seaweeds. It absorbs water quickly. Alginate has a wide use across a wide variety of industries including food, textile printing and pharmaceutical. In the food industry, it is used as a thickening agent for drinks and ice cream, and as a gelling agent for jellies.

Calcium alginate is a water-insoluble, gelatinous, cream-coloured substance that can be created through the addition of aqueous calcium chloride to aqueous sodium alginate. When liquid containing sodium alginate is dropped into another liquid containing calcium chloride, a thin membrane surrounding the droplets will be formed instantaneously. Spherification is the culinary process of these droplets that visually and texturally resemble roes.

There are two main methods for creating such spheres, spherification and reverse spherification. The use of method is dependent on the pH and calcium content of liquid.

***Food Test 17***

*Making of coffee caviar ─ formation of a thin, gelatinous membrane surrounding a drop of liquid.*

**Equipment & materials**

|  |  |
| --- | --- |
| **Equipment** | **Materials** |
| Scale  Saucepan  Spatula  Hand-held beater  Dropper / dropper bottle  Food container x 2  Caviar box  Small bowl x 3  Big bowl  Syringe  Spoon  Sieve  Molecular caviar spoon | Instant coffee powder 8 g  Sugar 8 g  Hot water 500 ml  Alginate 2.5 g  Distilled water 1 L  Calcium salt 10 g  Potable water (for rinsing) |

**Procedures**

1. Add alginate to heated coffee.
2. Blend with hand-held beater to dissolve alginate in coffee completely.
3. Add calcium salt into food container containing distilled water.
4. When coffee temperature reduces to 50-60oC, drop slowly into water with a dropper.
5. Remove coffee droplets into another food container containing potable water for rinsing.
6. Observe.

**Results**

|  |  |
| --- | --- |
| What is the consistency of the coffee after heating? |  |
| What is the state of coffee and alginate mixture before dropping into water? |  |
| How does a coffee mixture droplet look like after dropping into water? |  |
| How does the coffee droplet taste in your mouth? |  |

**Questions**

1. What may happen if a beverage containing calcium is used instead of coffee?
2. What other ingredient(s) can substitute coffee / coffee powder?