Practical Manual

FN 501. Advanced Food Science (2+1)

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2018

Exercise 1

Stages of Sugar Cookery

Introduction

Sugar is extensively used in confectionary and other foods. The kind of use depends upon the reactions that it undergoes. Much of candy-making starts with making syrup from sugar and water, and then cooking it to certain temperatures depending on the candy being made.

Depending on the source, there will be slightly different temperature ranges as well as descriptions for the various Cooked Sugar Stages. Therefore, it is best to use all of these tables as guides only to familiarize with the various stages of cooked sugar, their corresponding temperatures, what the cooked sugar looks like at each stage, and their uses.

The essential component contributing to **the texture of confectionery is the sugar crystal.** Sugar can be crystallized in different forms and sizes by varying factors influencing crystal growth.

From boiled sugar solution,**two types of confectionary** are prepared-**crystalline** and **no crystalline (amorphous)**.The temperature of boiling sugar solution,the ingredients used and method of handling the **super cooled solution determine the nature of the end product.**

Crystalline candies are chewed easily and they **may be cut with a knife**.The principal crystalline candies are **fondant and fudge**. Considerable care is required in the preparation of crystalline candy with a **smooth and velvety** structure.

Amorphous candies, in contrast, have a **heterogeneous** structure and **crack into pieces** rather than be cut with a knife.(eg.Toffee and brittles).Caramels, the softest of the amorphous candies, however,may be cut.The temperatures used for making different confections vary. The final temperature of syrup for **caramels** is **118^0 -120^0 C**.

During cooking, a **brown colour** develops owing to the **caramelization** of sugar and also due to reactions of amino groups of milk proteins and reducing sugars;milk is one of the ingredients.

In the preparation of caramels, corn syrup,fats and concentrated milk products are used as ingredients.

Brittles are made merely by the melting and **caramelization** of sugar. Toffee is made from simple sucrose syrup with **addition of cream of tartar,vinegar or lemon juice**. **Flavours** are added when the solution has **cooled sufficiently**.

Sugar, when heated by itself or in a highly concentrated solution, undergoes a change called **caramelization**.

Caramelization can be halted by the addition of water when the desired colour and flavour have developed.Sugar breaks down during caramelization and various organic acids are formed. Caramelization of sugar is useful in the preparation of confectioneries

Factors to be considered during sugar cookery

Cooked Sugar Stages (Fahrenheit/Celsius)

Stage	**Fahrenheit (^{0} F)**	**Celsius (^{0} C)**
Hard Ball	250-266 ^{0}F	122-130 ^{0} C
Soft Crack	270-290 ^{0} F	132-143 ^{0} C
Hard Crack	295-310 ^{0} F	146-155 ^{0} C
Caramel	320-360 ^{0}F	160-182 ^{0} C

To Convert Fahrenheit to Celsius = Subtract 32, multiply by 5, then divide by 9

To Convert Celsius to Fahrenheit = Multiply by 9, divide by 5, then add 32.

Procedure to test the different stages. Depending on the source you use, there will be slightly different temperature ranges as well as descriptions for the various Cooked Sugar Stages. Therefore, it is best to use all of these tables as guides only to familiarize yourself with the various stages of cooked sugar, their corresponding temperatures, what the cooked sugar looks like at each stage, and their uses.

One way to test for these stages, is **to drop about a teaspoon of the cooked sugar into a glass of cold water**. Then retrieve the sugar by pressing it gently between your thumb and forefinger and examine it to determine the stage. The higher the temperature of the cooked sugar, the less water there is in the sugar, so the firmer the sugar will be.

Another way to determine the stage of the cooked sugar is with an **accurate mercury or digital candy thermometer.**

High Altitude Guide for Cooking Sweets (in °F)

	2,000'	5,000'	7,500'
Soft ball	230-233	224-227	219-222
Firm ball	234-239	228-233	223-228
Hard ball	240-250	234-244	229-239
Small crack	260-274	254-268	249-263
Hard crack	275-289	269-283	264-278

Caramel	290-310	284-294	279 -289

Special features of sugar Cookery

- Making Sugar Syrups and caramel always begins with heating and melting ordinary granulated sugar and re-crystallizing it according to need. During the heating process the sugar first dissolves into syrup. As the temperature gets higher the syrup begins to thicken. As the temperature continues to rise and the water evaporates, the sugar begins to caramelize and turn a darker colour.
- As long as there is a lot of water in the syrup mixture the temperature will not raise much above the boiling point. As the water begins to evaporate the temperature of the mixture also begins to rise. As the water continues to evaporate, the temperature continues to rise. When most of the water has evaporated the temperature of the syrup will begin to rise rapidly.
- At 320 ^{0} F there is no water left, the sugar is melted and begins to caramelize, and the sweetness starts to decrease. The hotter the caramel gets the darker it becomes, and the deeper and less sweet the flavour becomes.
- Basically, temperature and the chemical interaction between a given component and the water molecule determine the component's solubility in water. Sucrose can be kept in solution in pure water at temperatures between 0 and 140°C.
- At temperatures above 100°C, pressurisation is necessary to achieve the solubility. The relatively high solubility of sucrose is an important parameter for its bulking effect in many foods and beverages. The dissolved sugar increases the viscosity of water-based solutions or mixtures, resulting in enhanced mouth feel.
- Dissolved sugar lowers the freezing point of ice cream by preventing the water molecules from combining to form ice crystals, which slows down the freezing process. The frozen water crystals no longer in solution increase the sugar concentration in the remaining solution and lower the freezing point even further.
- In bakery products, the solubility, or hygroscopicity, of sugar makes it compete with flour proteins and starch granules for the available water, which minimises gluten formation and decreases gelatinisation of the starch. This makes the final product more moist and tender, and the **hygroscopicity** of the sugar ensures that it remains that way longer.
- Mixing **glucose or invert sugar** with sucrose increases the solubility of the combined sugar matrix \and allows for production of products with higher total sugar solids than when using single components.
- Candy making is the preparation of candies and sugar confections. Candy making includes the preparation of many various candies, such as hard candies, jelly beans, gumdrops, taffy, liquorice, cotton candy, chocolates and chocolate truffles, dragées, fudge, caramel candy and toffee.
- Candy is made by dissolving sugar in water or milk to form syrup, which is boiled until it reaches the desired concentration or starts to caramelize.
- The type of candy depends on the ingredients and how long the mixture is boiled. Candy comes in a wide variety of textures, from soft and chewy to hard and brittle
- Formally the sugar syrup undergoes **6 distinct stages** or forms when it has been boiling from room temperature to the utmost temperature of **320^{0} F**(Ferenhite). These stages are named as per the methods used to test the syrup before thermometers became in use.

- The **"thread"** stage is the first stage which is tested by cooling a little syrup, and pulling it between the thumb and forefinger. When the correct stage is reached, a thread will form. This stage is used for making syrups.
- For subsequent stages, **a small spoonful of syrup is dropped into cold water**, and the characteristics of the resulting lump are evaluated to determine the concentration of the syrup. A smooth lump indicates **"ball" stages**, with the corresponding **hardness** described.
- At the **"soft crack"** stage, the syrup forms **threads** that are just **pliable.**
- At the **"hard crack"** stage, the **threads are brittle.**
- The **final texture** of candy depends on the **sugar concentration.**
- **As the syrup is heated, it boils, water evaporates, the sugar concentration increases, and the boiling point rises.**
- A given temperature corresponds to a particular sugar concentration. In general, higher temperatures and **greater sugar concentrations result in hard, brittle candies, and lower temperatures result in softer candies.**
- **Thread Stage:**
- Thread Stage is a cooking term meaning that sugar syrup being heated has reached 106 –

112⁰ C (223⁰– 234⁰ F.). It is a test of how hot sugar syrup is, and of how much water is left in

it. At this point of heating, the **sugar concentration** in the syrup is **80%.**

- It is tested by dropping a small amount of the sugar syrup from a spoon into a cup of cold water. If the stage has been reached, the syrup will form **fine threads or clump** for you at the bottom of the glass instead of **merely dissolving** away in the water instantly.
- The **Thread Stage** is called for in recipes **for syrups, fruit liqueurs and some icing.**
- **Soft-Ball Stage**: Soft-Ball Stage is a cooking term meaning that sugar syrup being heated has reached 112⁰ – 116⁰ C (234⁰ – 240⁰ F.) It is a test of how hot sugar syrup is, and of how much water is left in it.
- At this point of heating, the **sugar concentration** in the syrup is **85%.**
- To test this stage a small amount of the sugar syrup could be dropped from a spoon into a cup of cold water. If the stage has been reached, the syrup will come together and briefly form a soft ball or more accurately, a soft clump with a bit of height to it.
- If the clump is taken out of the water, it will hold its shape for a short while then start to flatten back down further. **The Soft-Ball Stage is used in making fudge, fondant, pralines, peppermint creams, Italian meringue, butter-creams, etc.**
- **Firm-Ball Stage**: Firm-Ball Stage is a cooking term meaning that sugar syrup being heated has reached 118⁰ - 121⁰ C (245⁰ - 250⁰ F.) It is a test of how hot sugar syrup is, and of how much water is left in it.
- At this point of heating, the sugar concentration in **the syrup is 87%.**
- To test this stage when a small amount of the sugar syrup dropped from a spoon into a cup of cold water, the syrup will form a firm ball or a firm clump. The ball when taken out of the water, will hold its shape, but it is very **pliable**. The **Firm-Ball Stage is called for in recipes for caramels, nougats, taffy, etc.**

- **Hard-Ball Stage**: Hard-Ball Stage is a cooking term meaning that sugar syrup being heated has reached 121 - 130 C (250 - 266 F.) It is a test of how hot sugar syrup is, and of how much water is left in it. At this point of heating, the **sugar concentration** in the syrup is **92%.**
- When a small amount of the sugar syrup from a spoon dropped into a cup of cold water the syrup will form a **firm ball (clump).** If it has been pressed down it will **hold its shape**; even after taking it out of the water and it will hold its shape.
- **Soft-Crack Stage**: Soft-Crack Stage is a cooking term meaning that sugar syrup being heated has reached 132^0 - 143 °C (270 °- 290° F.)
- As sugar syrup forms a firm ball(clump), it has been pressed down it will hold its shape;
- At this point of heating, the **sugar concentration** in the syrup is **95%.**
- This could be tested by drizzling a small amount of the sugar syrup from a spoon into a cup of cold water. In this the stage has been reached, the syrup will form **pliable threads** that will bend a bit before cracking. The sound of cracking is hearable and which is like the glass cracking, but it is the sugar. The simmering sugar syrup will have its **bubbles becoming denser.**
- The **Soft-Crack Stage** is called for in recipes for **butterscotch, salt water taffy,** etc.
- **Hard-Crack Stage**: Hard-Crack Stage is a cooking term, means that a sugar syrup being heated has reached **149 °- 154° C** (300° - 310 ° F.) It is a test of how hot a sugar syrup is. and of how much water is left in it.
- At this point of heating, the **sugar concentration** in the syrup is **99%.**
- It is being tested by drizzling a small amount of the sugar syrup from a spoon into a cup of cold water.When this stage has been reached, the syrup will form threads. It may actually hear cracking and be alarmed that it's the glass cracking, but it is the sugar.
- **Reaching** this stage requires a lot of constant stirring, at first with a whisk to ensure blending, then a wooden spoon.
- Once the **Hard Crack Stage** is reached, proceed with the recipe immediately before the sugar syrup turns to rock (it will also turn amber if heated more.) and begins to set immediately and it is too hot to.
- Once the syrup has passed hard crack, the cold water test won't show anything other than hard, brittle strands of sugar when dropped into water, and there are few uses for sugar syrup which has been boiled this high other than as a dessert decoration or a colouring additive to foods which need to be coloured brown such as gravy or treacle toffee.
- At this point there is little or no water left in the syrup, and the sugar begins to break down, creating **rich flavours as the sugar caramelises**, but which gradually **become bitterer as it burns**. **Caramelized sugar, on the other hand, is pure sugar that has been heated to 170° C.**
- At that temperature, the sucrose begins to break down and form other compounds. Results are delicious.
- **Caramelized sugar** has complex flavours, ranging from nutty to buttery and it's used to give **a rich taste to many desert items.**
- **Testing stages of sugar cookery:**
- **Candy thermometers** are the most accurate way of determining the temperature of boiling syrup. It should always be attached to the side of the pan after washing down sugar crystals.
- **Make sure that the thermometer does not touch the bottom of the pan.**

- Read the thermometer at eye level. Verify the accuracy of a **candy thermometer by checking its reading in boiling water.** Water normally boils at 212°F at sea level. If your thermometer does not read 212°F at sea level the thermometer is not accurate. (Water always boils at a lower temperature above sea level because there is less air pressure)
- **To adjust the temperature of a recipe, add or subtract the difference from 212°F as needed.**
- For example, if thermometer reads 210°F in boiling water and the recipe temperature is -5-
- 240°F. cook the syrup to 238°F, or 2°F less than the temperature required for that recipe.
- Much of candy-making starts with making syrup from sugar and water, and then cooking it to certain temperatures depending on the candy being made.
- All of the temperatures required are over 100^0 C, which at first seems impossible because the boiling temperature of water is 100^0 C and it can't get any hotter.
- **When water comes out of the syrup through evaporation, leaving behind molten sugar as an ever increasing percentage of the mixture as the water percentage diminishes. This makes the hotter than boiling water temperatures possible, and is also a gauge of both how cooked and how thick the syrup is, as well as what the nature of the molten sugar will be when cooled.**
- Depending on the source, there will be slightly different temperature ranges as well as descriptions for the various Cooked Sugar Stages. Therefore, it is best to use all of these tables as guides only to familiarize with the various stages of cooked sugar, their corresponding temperatures, what the cooked sugar looks like at each stage, and their uses.
- One way to test for these stages is to drop about a teaspoon of the cooked sugar into a glass of cold water. Then retrieve the sugar by pressing it gently between your thumb and forefinger and examine it to determine the stage
- **The higher the temperature of the cooked sugar, the less water there is in the sugar, so the firmer the sugar will be.**
- Another way to determine the stage of the cooked sugar is with an accurate mercury or digital candy thermometer.
- As it is known that each of the stage of sugar cookery falls within a range of temperatures, gives some leeway over **how hard or soft type of sweet** is to be made.
- **This is another advantage of the cold water test over a thermometer – where one can feel with fingers exactly how firm syrup has become and make allowance for having miscalculated the measures for any of the ingredients.**
- Following on from that particular advantage, one more reason why the cold water test is more accurate for making sweets at altitude.
- As altitude increases, atmospheric pressure drops and the boiling point of water occurs at progressively lower temperatures. Boiling the sugar to the same temperature at say, 10,000' (about 3,000 metres) as would at sea level, the sweets would be overcooked. **The cold water test will give the same results regardless of altitude, and helps to turn out perfect sweets every time.**
- **As dry sugar is heated it melts to a colourless liquid and it soon develops a brown colour, giving a pleasing characteristic caramel aroma at 177^0 C. The sugar begins to burn and develops a bitter, burnt taste and used for caramel pudding and wines.**

AIM:

To determine the importance of different stages of sugar

Materials Required

Sugar, Cold Water, Steel vessel, glass vessel, steel spoons, petri dish, Thermometer.

Exercise:

- **Preparation of different stages of Sugar cookery**
- **Observe the temperature**
- **Observe changes that occurs in each stage**
- **Explain various products that can be prepared at each stage**

Procedure: 50 grams of sugar was weighed and melted it in 100 ml water. Note down the Temperature of different stages of sugar cookery by using thermometer. Give description at each stage of sugar cookery as you observe.

Observation:

Stages	**Temperature Observed0^0 C**	**Description**	**Products that can be Prepared.**
Thread Stage	110^{0}C-112^0 C	Syrup spins 5 cm thread between thumb and first sugar Syrup will form a loose thin thread. **Sugar concentration -80%**	Preparation of Jellies.Gulab Jamun.Used for sugar syrup.
Soft ball	112^{0}C-115^{0}C	Drop syrup in cold water, it forms a soft sticky ball and these balls flatten on removal of water. **Sugar concentration-85%**	Preparation of crystal, candies, fondant and fudge,pralines
Firm ball	118^{0}C-120^0 C	Forms a firm ball when syrup is dropped in to very cold water, it does not flatten, holds it shape briefly, on removal from water. **Sugar concentration-87%**	Caramel, Candy, Butter creams, nougat ,marshmellows, Italian meringues,gummies and toffees.

Hard ball	120 ^{0}C-130^0 C	Drop in to very cold water, it forms balls that are hard enough to hold its shape but still it is plastic syrup when dropped. **Sugar concentration-92%**	Peanut Candy.Marshmellow,Laddu. Caramels,nougat,divinity,toffees.
Soft crack stage	132 ^{0}C-143^{0}C	Forms threads which are hard but not brittle when syrup is dropped into cold water. **Sugar Concentration-95%**	Preparation of various toffees. Butterscotch Toffees,firm nougat, and taffy.
Hard Crack	150^{0}C-154^0 C	Syrup dropped in to water, separate it into thread, which is hard and brittle. **Sugar concentration-99%**	Peanut Brittle, Glace,toffees,hard candy
Clear liquid	160 ^{0}C	Sugar Liquidifies. at this stage all the water has boiled away. remaining sugar is liquid and light amber in colour. **Sugar concentration-100 %**	Brittles, pralines, caramel coated molds and nougatine.
Brown Liquid	170^{0}C	When clear liquid is heated further gets brown liquid. **Sugar concentration-100%**	Caramel

Result and discussion:

Explain in detail about stages of sugar cookery, as sugar syrup is cooked, different stage of sugar from thread stage to caramel stage has to be observed and changes due to increase in temperature. The rise in temperature makes water boil away and increase concentration of sugar. Hence, from the thread stage, temperature increases step by step to caramel stage.

Inference:

Comment scientifically the changes that occur during sugar cookery with adequate supporting studies.

Exercise 2

Effect of Cooking on Carbohydrate

Introduction:

Carbohydrates (from "Hydrates of carbon") are organic compounds with the basic structure $C_2 (H_2 O)_y$ - Monosaccharide, disaccharides, polysaccharides etc.Important types of carbohydrate s in food are the sugars, dextrins, starches, cellulose, hemicelluloses, pectins and certain gums or their derivatives. Carbohydrates are the major proximate principle which is the staple food of a large population. Carbohydrates are our body's main source of fuel. Carbohydrates are most easily converted to glucose, which is used by our cells for energy. Our body systems and organs need glucose to function properly. The basic building blocks of carbohydrates are sugar molecules, which join carbon, hydrogen and oxygen.

Healthy Carbohydrates

- Different types of carbohydrates include simple and **complex** carbohydrates, the latter of which is often a **good source of fiber**.
- Simple carbohydrates include sugars found naturally in fruits, vegetables and milk, as well as those added in food processing.
- **Complex carbohydrates** are found in whole grain breads, cereals, starchy vegetables and beans.
- Carbohydrates are primarily found in foods with grains, sugars and fiber.
- Simple carbohydrates are foods made with sugars, such as fruit sugar or table sugar.
- Complex carbohydrates are made when a food contains three or more linked sugars.

- **Complex carbohydrates are healthier** than simple carbohydrates, and include oatmeal, whole grains and beans.

Importance of Carbohydrate

- Carbohydrates are also a source of energy and can supply important vitamins and minerals. **One** gram of **carbohydrate provides 4 Kcal.**
- Carbohydrates are one of three proximate principles in your diet. The others are protein and fat.
- Carbohydrates are converted to glucose as the primary source of energy for your body.
- Despite the bad reputation carbohydrates have received, most of them are actually **good for us, including fresh fruits, vegetables and whole grains, which provide our body with essential vitamins, minerals and fiber.**
- The carbohydrates in our diet come primarily from the bread, cereal and grain food group, as well as the fruit and vegetable group.
- These foods are naturally **higher in fiber, helping you feel full longer.**

Cooking Process:

There are two possible changes that occur when carbohydrates are cooked.

- **Caramelization** occurs when the sugars in the carbohydrates are browned. When bread turns golden brown on top, it is an example of the sugars becoming caramelized.
- **Gelatinization** occurs when the starches in carbohydrates absorb water and begin to swell. This chemical change is used to make cooked sauces, breads and other baked goods.

- When you add certain carbohydrates, such as flour, to liquids, the heat gelatinizes the carbohydrates. This is the process used to make gravy and other thick sauces.Starch, a complex carbohydrate, has powerful thickening properties.
- When starch is combined with water or another liquid and heated, individual starch granules absorb the liquid and swell.
- This process, known as **gelatinization**, is what causes the liquid to thicken. Gelatinization occurs at different temperatures for different types of starch.
- As a general **rule of thumb**, **root-based starches** (potato and arrowroot, for instance) **thicken at lower temperatures** but break down more quickly, whereas **cereal-based starches** (corn and wheat, for example) thicken at **higher temperatures** but break down more slowly.
- **High** levels of **sugar** or **acid** can **inhibit** gelatinization, while the presence of **salt can promote** it.

Special features of Carbohydrate Cooking

- Carbohydrates come in various forms, and each form reacts differently when exposed to heat. The **two forms of carbohydrates** that are of interest from a basic food science perspective **are sugar and starch.**
- When **exposed to heat, sugar** will at first **melt** into **athick syrup**.
- As the temperature continues to rise,the sugar syrup changes color, from clear to light yellow to a progressively deepening **brown**.
- This browning process is called **caramelization**. It is a complicated chemical reaction, and in addition to color change, it also causes the flavor of the sugar to evolve and take on the rich complexity that we know to be characteristic of caramel.
- Different types of sugar caramelize at different temperatures.

- Granulated white sugar melts at 320°F/160°C and begins to caramelize at 338°F/170°C.

- In foods that are not primarily sugar or starch, a different reaction, known as the **Maillard reaction**, is responsible for browning. This reaction involves sugars and amino acids .When heated, these components react and produce numerous chemical by-products, resulting in a brown color and intense flavor and aroma.

  It is this reaction that gives coffee, chocolate, baked goods, dark beer, and roasted meats and nuts much of their rich flavor and color.

- Both **caramelization and the Maillard reaction typically require relatively high heat (above 300°F/149°C)** to occur rapidly enough to make an appreciable difference in foods.

- Because water cannot be heated above 212°F/100°C unless it is under pressure, foods **cooked with moist heat (boiling, steaming, poaching, stewing) will not brown.**

- **Foods cooked using dry-heat methods (sautéing, grilling, or roasting) will brown.** It is for this reason that many stewed and braised dishes begin with an initial browning of ingredients before liquid is added.

Aim:

To study the effect of cooking carbohydrate

Materials Needed:

Wheat Flour

Ragi Flour

Roasted Rice Flour

Water

Exercise:

1.Watch the changes occurring during cooking of carbohydrate.

2.Use different types of cereals

3. Observe the temperature and time taken for gelatinization

4. Observe the temperatures.

Procedure: Starch granules do not dissolve readily in cold water but they will form temporary suspension with starch and settle down as soon as mixture is allowed to stand. **When heated with water, intermolecular high bonding is broken and grains absorb water, swells and viscosity increases until a peak thickness is reached** .Translucency of mixture also increase. These changes are known as gelatinization.

*Twenty five grams of new wheat flour, roasted rice flour, corn flour, Ragi flour was weighed and each flour was cooked in 300 ml water and these were heated until gelatinization took place.

* Gelatinization temperature and time taken for completion of gelatinization were noted. Thickness of gel formed was also observed.

Observation:

Type of Flour	Gelatinization	
	Time	Temperature
Wheat flour	6 min 51 sec	75 ^{0}C
Ragi flour	7 min 14 sec	99 ^{0}C
Roasted rice flour	7 min 43 sec	93 ^{0}C
Corn flour	4 min 38 sec	65 ^{0} C

Results and discussions:

- Explain in detail about the gelatinization temperatures and time taken for gelatinisation of wheat flour and corn flour as compared to ragi and roasted rice flour.
- Is it low gelatinization temperature compared to ragi and roasted rice flour?
- Is it because gelatinization temperature physio- chemical properties varies with different starches. Reason out?
- The behaviour of starch in water is temperature and concentration dependent.
- Hence wheat and corn flour have gelatinized earlier than ragi and roasted rice flour.

Inference

Scientifically comment on the effect of cooking on carbohydrate with supportive studies.

Exercise 3

Effect of Additives on Stability of Egg white foam

Introduction:

An egg white is about 90% water and 10% protein. **The egg-white proteins are long chains of amino acids that fold and curl into more or less spherical tangles.** When you beat an egg white, these proteins uncurl and stretch out.

As you beat the egg whites, you also whip bubbles into the mixture. The water molecules and egg-white proteins bump around, jockeying for position. The water molecules are attracted to each other and to the **hydrophilic amino acids on the proteins.** While trying to get close to each other and to the hydrophilic amino acids, the water molecules **squeeze the hydrophobic amino acids out**. The best place for the egg proteins is on the surface of the liquid, with their hydrophobic amino acids sticking out into the air.

The surface of each bubble film becomes crowded with egg proteins. The water molecules are forced apart by these proteins. Since the **attraction between water molecules decreases with distance, the water molecules don't stick together quite as well—they can spread out and make a bubble film**. Egg foams can be incorporated into a variety of dishes, such as meringues, cakes, soufflés, sauces, mousses, and cocktails

Special Features

- All foams are a type **colloidal dispersion** known as a **suspension,** in which air is dispersed throughout a (usually) liquid phase without dissolving.
- The special proteins in egg whites are what allow stable foams to form. Proteins are large molecules, as molecules go.
- Because they're so big, there are areas along their chain that are **hydrophilic** (water-loving) and areas that are **hydrophobic** (water-fearing).
- In nature, proteins fold themselves into a specific shape based on these characteristics. They keep their hydrophobic areas on the inside, where they are protected from exposure to water, and their hydrophilic areas on the outside.
- In case of **egg yolk, foam** formation was **delayed**.
- The egg white foam when beaten with **salt**, the **time** taken for beating **decreased** and **volume** of foam was **more**, **shiny** and **white** and resulted in **fine stable foam** It increases stability because of **increase in volume of foam** will be **elastic**. Water drained was also less when compared to other foams showing a better stability.
- When egg white foam treated with **acid** results in **fine stable foam** because it **reduces** the **pH of egg white foam**. Formation of foaming delay which results in increase total agitation and **fine stable foam**.

- Egg white foam when treated with **egg yolk, stability is reduced**. Since the **fat** present in the **egg yolk interferes** with foam formation. This effect is the result of fat
- Probably the lipoprotein in the egg yolk which may form a complex with proteins in the white.
- Adding **vinegar** (or any other acid) can make the foam less likely to suffer the consequences of **overbeating-lumpiness, loss of water, and collapse**. These undesirable consequences result from **too many bonds forming** between the egg proteins.
- When you add an **acid** to a mixture, you are essentially adding some **positively charged particles**. These positively charged particles are **hydrogen ions**—hydrogen atoms that have lost an electron. The **hydrogen ions hop onto charged** portions of the **proteins** and leave them uncharged. Proteins that are electrically neutral are less likely to react with other proteins.
- Egg white foam when **diluted with water** results in **soft less stable foam.** Because dilution of egg white with water up to 40 % of the volume of egg **increases** the **volume** of foam, but **decreases the stability**.
- Egg white when treated with **fat** result in **soft watery** foam. It **decreases the stability** of the foam. The presence of fat interferes with foam formation and **decreases** the foam.
- Similar effect is observed when **egg yolk** is added to white. This effect is the result of the fat probably the lipoproteins in the yolk, which forms a complex with proteins in the white.
- Egg white foam when treated with **sugar** results in **fine, less stable foam.**
- If **sugar is added before beating** is started, **extensive beating is needed to produce foam, once formed.**
- **The foam is stable and very fine although the volume maybe less.** After sugar has been beaten into a foam.it can stand for sometimes without becoming coagulated and losing its elasticity.

So how can overbeat egg whites be salvaged?

"All is not lost. As long as you haven't added any other ingredients, you can usually resurrect a **foam by adding an extra egg white** and beating just until the mixture looks **glossy and forms peaks again."**

Aim:To study the effect of various additives on the stability of egg white foam

Materials Required

Egg Whites/Egg yolk/Salt/Sugar/Oil/Citric acid/Water/Beater/Whisker

Procedure:

Two important factors to egg white foams are **stability** and **volume.** Extend of beating is an important factor in the stability of egg white foam. As beating progresses the foam becomes increasingly stable up to an initial point after which, continuous beating decreases stability.

Maximum stability is reached when the white just bend over but before **maximum volume** has been reached. If beating continues beyond the point of maximum stability the surface begins to look slightly dry and foam exhibits some brittleness.

Exercise :

- **Prepare the egg white foam using the following procedure.**
- **Record the time taken for foam formation (stiff peak).**
- **Record the colour of foam, stiffness, dull or shiny texture.**
- **Record the results of effect of the addition of various additives on the egg white foam.**

Procedure:

A- **Preparation of Egg white Foam.**

1. Separate the Egg white from the egg yolk.
2. Beat white to stiffy peak stage using rotary beater or whisk and note the time taken for foam formation.
3. Transfer the prepared foam to a funnel lined with filter paper and place over a measuring cylinder. Keep aside for 45 minutes and record the volume of liquid drained.

Variations:

B. Add 1/8th teaspoon salt while preparing foam

C. Add 1/8th teaspoon of citric acid

D. Add 1/4th of egg yolk and beat to attain the foam

E. Add 10 ml of water and then beat.

F. Add 2 teaspoon of sugar.

G. Add 10 ml of oil and beat.

H. Use a different types of beaters and whiskers

N.B. Keep B to H also for 45 minutes to compare the result of samples. A to H with respect to time taken for foam formation (stiff peak), colour of foam, stiffness, dull or shiny texture. Record the results.

Observation:

	VARIATIONS	MXM time for beating (mnts)	TIME TAKEN FOR BEATING (minutes)	COLOUR	TEXTURE	GLOSSY(SHINY OR DULL)	STABILITY Yes/No	DRAINED LIQUID ml
A	Egg white	10	9	White	Stiff	Shiny	Yes	13
B	Salt	10	12	White	Stiff	Shiny	Yes	9
C	Citric acid	10	10	White	Soft	Shiny	Yes	12
D	Egg white + Yolk	10	20	Off white	Soft	Shiny	No	7
E	Water	10	12	White	Soft	Shiny	No	13
F	Sugar	10	17	Creamy white	Soft	Shiny	No	10
G	Oil	10	10	Yellow	Soft	Dull	No	16

Result and discussion:

Explain the results scientifically.

- **Different stages of foam formation are recognised based on the appearance of the foam-when egg white is beaten with a beater and whisker and effect of various additives on egg white foam.**
- The first stage when the egg white is beaten slightly, the bubbles are formed at the surface but a small amount of liquid remains in, the bottom of the bowl.
- At this stage, air bubbles are large and less in number.
- As beating is continued beyond this stage, more air is incorporated into the bubble causing the white more opaque in appearance.
- Air bubbles becomesmaller as agitation continues and foam becomes soft.
- On further beating, when the beater is withdrawn from the foam the peak will adjust bend over and is called **soft peak stage**.

- Air bubbles become very small and foam becomes stiff and shiny on further beating and this called **hard peak stage**.
- The peak stands upright when the beater is withdrawn. If beating is continued **beyond stiff peak stage, a dry foam** is produced which is very white but **dull** and breaks in to small flakes or **curdled textured** and forms dry foam.
- Egg white foam when **added with sugar delayed foam** formation. Volume of foam was more and foam was shiny and glossy in appearance. The liquid drained is more resulting in **decreased stability**.
- Egg white foam when added with **salt** was having foam with **more volume, shiny** and **white** appearance.
- Egg white foam prepared by the addition of **oil** resulted **poor foam with less volume**.

Inference:

Scientific comments on the effect of various additives upon the stability of egg white foam with supportive studies.

Exercise 4

Preparation of Emulsion

Introduction:

An emulsion is liquid preparation containing two immiscible liquids, one of which is dispersed as globules (dispersed phase = internal phase) in the other liquid (continuous phase = external phase).

To stabilize these droplets, emulsifying agent should be added

- Micro emulsion: Droplets size range 0.01 to 0.1μ m
- Macro emulsion: Droplets size range approximately 5μ m.

Special features of Emulsions:

Emulsified Dressings

- **Mayonnaise** and mayonnaise dressing are emulsified semisolid food products prepared from edible vegetable oil, egg yolk-containing ingredients and the following acidifying and flavoring ingredients:
- 1.Salt;
- 2.Nutritive carbohydrate sweeteners, such as sucrose, dextrose, corn syrup, glucose syrup, or honey;
- 3.Mustard, paprika or other spices, spice oils or spice extracts, except turmeric or saffron, and no spice oil or spice extract which imparts to the mayonnaise a colour simulating that imparted by egg yolk;
- 4.Any suitable, harmless food seasoning or flavouring (other than imitations), provided it does not impart to the mayonnaise a colour simulating that imparted by egg yolk;
- 5.Monosodium glutamate;
- 6. Acidifying ingredients, which may be any vinegar of not less than 2.5% acetic acid, or frozen, canned, concentrated or dried lemon or lime juice with a total acidity of no less than 2.5% calculated as acetic acid; citric or malic acid may be used in a proportion not to exceed 2.5% of the acid of the vinegar calculated as acetic acid.

A typical commercial mayonnaise formula:

Vegetable oil	78.5%
Vinegar, white (10%)	3.8%
Water	11.6%
Sugar	1.8%
Salt	1.2%
Spices (mustard, onion, etc.)	0.3%
Dried egg yolk solids	2.8%

- This formula provides a **mayonnaise with medium viscosity.**
- For a **heavier viscosity**, vegetable **oil** may be increased to **80.5%** and **water** decreased to **9.6%.**
- Mayonnaise may be mixed and packed in an inert atmosphere in which air is replaced totally or in part by carbon dioxide or nitrogen.
- Dried egg-yolk solids may be substituted for liquid egg yolk on a total solids basis.

How to control emulsion type during formulation?

a. **Volume** of **internal** and **external** phases controls the **type** of **emulsion**. The smaller volume will be for the internal phase and the larger volume will be for external phase. In some cases, internal phases can be more than 50% of the total volume.

b. Dominance of polar and non-polar characteristic of emulsifying agents (relative solubility of emulsifying agent in water and oil). **Dominance of polar part results in formation of o/w emulsion and dominance of non-polar part results in formation of w/o emulsion. Note** that **polar** groups are **better barriers** than **non-polar**; therefore, o/w emulsion can be prepared with more than 50 % of oil phase "**internal phase**".

Composition and Processing:

- **Mayonnaise** usually contains the following ingredients:
- **Oil, emulsifier** (egg yolk prescribed in some countries), **vinegar** (as pH regulator and as flavor), **spices, flavors** (sugar, salt, mustard) and **stabilizers** (thickeners for mayonnaise with <70% oil only).
- Mayonnaise with 80% oil approaches the limit for stable oil in water emulsions, which are unstable above 85% oil. With more oil, the packaging of oil droplets is too dense to allow for an emulsion.
- The high viscosity of mayonnaise results from the already high **droplet density at 80%.**
- The taste of mayonnaise is very different in certain countries.
- In **Europe**, it has a **slightly sour** blend taste, and in the Mediterranean area, mainly **lemon juice or vinegar and oil**. It becomes **sweeter** and has a more **mustard** taste when going north and is **very sweet** in **Scandinavia.**
- To produce mayonnaise, the **egg yolk which is rich in lecithin** is mixed with the ingredients, the **water** and 1/3 rd of the vinegar, and stirred to **high viscosity.**
- The temperature during this process, called **"cold process"** should **not rise above 5°C**.
- Then add slowly the rest of the vinegar and the oil are added. The **"hot process"** uses temperatures of ~70°C and warm filling.
- The typical flavor of **mustard** in many countries is the **allyl - thiocyanate** of mustard.
- **Vinegar** intensely influences **microbiological stability**; the **lower the pH**, the **more stable** the product. This means that production of mild, i.e., less sour, mayonnaises requires higher hygienic standards in manufacturing.
- **Mayonnaises** in the market usually have a **pH between 3 and 4.**

Aim:

To determine the best method of preparing stable emulsion like mayonnaise.

Principle:

- Mayonnaise is an emulsified salad dressing which requires ingredients in certain proportion to be mixed together to form stable oil in liquid emulsion. The egg foaming about 20% of the total weight provides the **emulsifying agent lecithin** present **in the yolk.**
- This helps in stabilising the other ingredients in the mixture.
- White egg may be used in the preparation of the products.

- It is the **yolk** which has better stabilising ability as they hold moisture in dispersion.
- Therefore the ratio of other ingredients such as **salt, vinegar and spices** should **not exceed 65:10:5 percentage** of the weight of the egg contents since the yolk have limited assimilating power.
- Continuous beating breaks up liquid to convert to a semi solid stable product.

Materials Required:

Egg-1

Sugar -2 g

Salt-1.5 g

White pepper powder-0.6 g

Salad oil- ½ cup (118ml)

Corn starch- 6 g

Mustard-0.6 g

Procedure:The activity is divided in to four section A, B, C and D to study the effect ofvariations in the end result and to determine the most suitable method and preparing mayonnaise for different application.

A. Method of preparing mayonnaise:

1. Separate yolk from the eggs and drop in to a small bowl.
2. Add salt, sugar and white pepper powder.
3. Beat with beater till all the ingredients are well-blended.
4. Add oil drop by drop alternating with vinegar,while continuously beating the mixture. Continue beating till the mixture begins to thicken.
5. Continue the process gradually increasing the quantity of oil, add at one time till all the ingredients are added and the end product is spoon able into a jar.
6. Observe colour, consistency and flavour.

Note: Beating should be continuous.

B. Effect of varying Methods of combining in ingredients.

1. Add seasoning and vinegar to the yolk and then start whisking. Add oil as in A(4.5) and keep the sample aside for assessment.

C. Effect of substituting Emulsifying Agents.

1. Make a starch gel with ½ teaspoon of corn starch and ½ cup of water, cool the gel.

Take 2-7% of gel contents and add it to the egg yolk with all other ingredients except oil and mix together. Add oil as in A(4) and follow the procedure till A (5). Keep the sample aside for assessment.2. Substitute whole egg for yolk and proceed as in A. Keep the sample aside.

D. Effect of temperature of ingredients on formation of Emulsion.

1. Heat oil and vinegar separately to 100^0 C. combine the ingredients as in A. Keep aside for assessment.

Exercise:

- **Prepare and observe the formation of Emulsion**
- **Observe and record all changes occurring during various variations (A`to D)**

Observation:

Sensory quality of Mayonnaise for different variations:

VARIATION	APPEARENCE	STABILITY	TASTE	MOUTH FEEL	APPLICATION
A	DARK YELLOW	NOT STABLE	SOUR	WATERY	PIZZA TOPPING
B	PALE YELLOW	NOT STABLE	SOUR	WATERY	PIZA TOPPING
C (1)	YELLOW	NOT STABLE	SOUR	SMOOTH	PIZZA TOPPING
C(2)	THICK CREAMY WHITE	STABLE	SOUR	SMOOTH	SALAD DRESSING
D	PALE YELLOW	NOT STABLE	SOUR	WATERY	SALAD DRESSING

Result and Discussion:

- Mayonnaise is an oil-in-water emulsion which is stabilised with **egg yolk lecithin.**
- The sensory qualities of mayonnaise prepared with different variations shows that in (A) the appearance is dark yellow with sour taste and is watery in nature. Why is it so?In (B), the appearance is pale yellow with sour taste –what are the reasons?
- In (C)-1 the appearance is pale yellow with smooth mouthful- explain? All the above can be used as pizza toppings-explain?
- The product (C) is thick creamy white in appearance with sour taste and smooth to mouthful- explain the changes?

- The variation (D) was found to be pale yellow in colour with sour taste and watery mouthful- explain changes occurring in it?
- This can be used in Salad dressing- explain its importance?
- Among the five products the most stable one was (C)-2 where whole egg was used instead of egg yolk alone.
- The best method of preparation of mayonnaise is (C)-2 because here whole egg was used with other ingredients – Why?
- In mayonnaise, the emulsifier is **egg yolk** which contains **lecithin** which acts as fat emulsifier – explain?
- Eggs contain the emulsifier lecithin.
- It has the ability to bind the ingredients together and thus obtain a stable emulsion.

Inference:

Attribute to the various scientific aspects observed in the preparation of emulsion with supportive studies.

Exercise 5

Effect of Additives on Carbohydrate

Introduction:

- **Rice (*Oryza sativa*)** starch is the major energy source for many millions of people around the world.
- Starch is a polymer of glucose which presents as a mixture of two forms, **amylose** and **amylopectin.**
- Amylose is principally composed of a linear polymer of α(1–4)-linked glucose with some α(1–6) linkages,
- Whereas amylopectin is a more complex mixture of both α(1–4)-linked glucose extensively branched byα(1–6) linkages.
- In its native state, rice starch has a semi crystalline structure which **is disrupted by cooking, transforming the starch into a softer, edible, gel-like material.**
- Because it is associated with the **cooking time** and **texture** of cooked rice and **cool** cooked rice. **the temperature** at which rice starch **gelatinizes** is an important component of **rice eating quality**.

Special Features:

- Starch is synthesized by the activity of several enzymes and has been the subject of extensive recent reviews.
- Regardless of the subsequent synthetic path, glucose is first activated in preparation for starch synthesis by adenosine-5'-diphosphate glucose pyrophosphorylase (AGPase), and the adenosine-5'-diphosphate glucose so produced becomes the substrate for the starch syntheses (SSs).
- Granule-bound starch syntheses (GBSS) is exclusively responsible for the synthesis of amylose, and the SSs extend the α(1–4) links of amylopectin.
- Starch branching enzymes (SBEs) insert α(1–6) branches in the amylopectin chains, whereas starch debranching enzymes (SDBEs) cleave the growing chains at α(1–6) linkages in what is believed to be a necessary part of the process of remodelling the growing amylopectin, allowing it to crystallize.
- Each of these enzymes occurs as a number of different isoforms which display tissue-specific expression.

A link between the gelatinization temperature (GT) of rice starch and enzymes of starch biosynthesis has been made, with the finding that a major gene that controls rice GT, as determined by the indirect measure of alkali spreading.

Rice gelatinization is a process of-

- **Breaking** down the intermolecular bonds of **starch** molecules in the presence of **water and heat**, allowing the hydrogen bonding sites (the hydroxyl hydrogen and oxygen) to engage more water. This irreversibly dissolves the **starch** granule in water.
- The cooking quality of rice is associated with the **starch gelatinization temperature(GT).** Rice genotypes with low GT have probably been selected for their cooking quality by humans during domestication.

Retrogradation of Rice is a process of-

- **Retrogradation** is a reaction that takes place when the **amylose** and **amylopectin** chains in cooked, **gelatinized starch realign** themselves as **the cooked starch cools.**
- When native **starch** is heated and dissolved in water, the crystalline structure of amylose and amylopectin molecules is lost and they hydrate to form a **viscous** solution.
- If the viscous solution is cooled or left at lower temperature for a long enough period, the linear molecules, amylose, and linear parts of amylopectin molecules retrograde and rearrange themselves again to a **more crystalline structure.**
- The linear chains place themselves parallel and form **hydrogen bridges**.
- In viscous solutions the viscosity increases to form a gel. At temperatures between – 8 and +8 °C the aging process is enhanced drastically.
- **Retrogradation can expel water from the polymer network. This is a process known as syneresis.**
- A small amount of water can be seen on top of the gel. Retrogradation is directly related to the **staling** or aging of bread.
- Retrograded starch is **less digestible**.
- Chemical **modification of starches** can reduce or enhance the **retrogradation. Waxy, high amylopectin,** starches also have a much **lesser tendency to retrogradate**.
- Additives such as **fat, glucose, sodium nitrate and emulsifier can reduce retrogradation of starch.**

- Compared to raw rice starch, the **acid-treated** starch exhibited increases in apparent **amylose content**, blue value, dextrose equivalent, cold-water solubility and transmittance, and decreases in wavelength of maximum absorbance, viscosity, and gel- forming ability, reported in various studies.
- **Rice, the lifeblood** of so many nations' cuisines, is perhaps the **most ubiquitous food in the world**.
- In Asia, where an estimated 90 percent of all rice is consumed, the pillowy grains are part of almost every meal.
- In the **Caribbean**, where the starch is often mixed with beans, it's a **staple** too.
- Even in the **United States**, where people eat a comparatively modest amount of rice, plenty is still consumed.
- Rice is popular because it's malleable—it pairs well with a lot of different kinds of food—and it's relatively **cheap**.
- But like other starch-heavy foods, it has one central flaw: it isn't that good for you.
- **White rice consumption**, in particular, has been linked to a **higher risk** of diabetes.
- A cup of the cooked grain carries with it roughly 200 calories, most of which comes in the form of **starch**, which turns **into sugar**, and often thereafter **body fat**.

- **But what if there were a simple way to tweak rice ever so slightly to make it much healthier?**

- An undergraduate student at the College of Chemical Sciences in Sri Lanka and his mentor have been tinkering with a **new way to cook rice that can reduce its calories by as much as 50 percent and even offer a few other added health benefits.** The ingenious method, which at its core is just a simple manipulation of chemistry, involves only a couple easy steps in practice.

- "What we did is **cook the rice as you normally do, but when the water is boiling, before adding the raw rice, we added coconut oil—about 3 percent of the weight of the rice you're going to cook,**" said Sudhair James, who presented his preliminary research at National Meeting & Exposition of the American Chemical Society (ACS). **"After it was ready, we let it cool in the refrigerator for about 12 hours. That's it."**

- **How does it work?**

- To understand what's going on, we need to understand a bit of food chemistry.

- Not all starches, as it happens, are created equal.

- Some, known as digestible starches, take only a little time to digest, are quickly turned into glucose, and then later glycogen.

- Excess glycogen ends up adding to the size of our guts if we don't expend enough energy to burn it off.

- Other starches, meanwhile, called resistant starches, take a long time for the body to process, aren't converted into glucose or glycogen because we lack the ability to digest them, and add up to fewer calories.
- A growing body of research, however, has shown that **it might be possible to change the types of starches found in foods by modifying how they are prepared.**
- **Rice, depending on the method of preparation, undergoes observable chemical changes.** Most notably, fried rice and pilaf style rice have a greater proportion of resistant starch than the most commonly eaten type, steamed rice.
- "If you can reduce the digestible starch in something like steamed rice, you can reduce the calories," said Dr. Pushparajah Thavarajah,Srilanka, a professor who is supervising the research. **"The impact could be huge."**
- Scientists tested eight different recipes on 38 different kinds of rice found in Sri Lanka.
- **What they found is that by adding a lipid (coconut oil in this case, because it's widely used in Sri Lanka) ahead of cooking the rice, and then cooling the riceimmediately after it was done, they were able to drastically change its composition—and for the better.**
- **"The oil interacts with the starch in rice and changes its architecture."**
- "Chilling the rice then helps foster the conversion of starches. The result is a healthier serving, even when you heat it back up."
- **So far they have only measured the chemical outcome of the most effective cooking method for the least healthful of the 38 varieties.**
- But that variety still produced a 10 to 12 percent reduction in calories. "With the better kind, we expect to reduce the calories by as much as 50 to 60 percent,".
- **Cooking that can change the world**
- **The prospect of lower caloric rice is a big deal.**
- **Obesity rates are rising** around the world, particularly in the developing world, where **people rely more heavily on cheaper food staples.**
- **China and India**, which are already seeing rising **obesity** problems,are **hugeconsumers of rice**.
- Rice, of course, is not the sole cause of weight gain. **But reducing the amount of calories in a cup of rice by even as little as 10 percent could have an enormous impact for future generations.**

- "Obesity has been a problem in the United States for some time.""But it's becoming a problem in Asia, too. **People are eating larger and larger portions of rice, which isn't good."**

- The researchers still have to test the remaining varieties of rice,which they believe will **produce the largest calorie reduction.** They also plan to experiment with oils other than coconut oil, like sunflower oil.

  A **world where commercially sold rice comes pre-cooked and with much fewer calories might not be that far off.**

- People should already be able to replicate the process at home, although James warns the results might vary depending on the type of rice used. **And there's good reason to believe the chemistry could be applied to many other popular healthy foods.**

Aim:To study the effects of additives on Carbohydrate.

Gelatinization:

- It is a process of breaking down the inter molecular bonds of starch molecules in thepresence of water and heat, allowing the hydrogen bonding sites to engage more water.
- This irreversibility dissolves starch granules in water.
- Water acts as a plasticiser.
- The gelatinization temperature of starch depends on plants type and the amount of water present, pH and concentration of salt, sugar, fat and protein.

Retro gradation:

- Cooked, unmodified starch, which cooked for a long enough period, will thicken (or gel) and rearrange itself again to a more crystalline, structure, this process is called **retrogradation**.
- Starch **retrogradation** is one of the undesirable processes which occur during the storage of starchy foods.
- Many additives can be used to retard retrogradation of starch in foods.
- When compared to the additives used in the experiments, **fat showed delay in retrogradation**.
- During retrogradation, **amylose** is more **easily retrograded**.
- The addition of fat in starch-water systems can hinder water penetrations into granules and hinder amylose leaching during heating.
- As a result, the mobility of amylase molecules is constrained, resulting in slower retrogradation.
- Addition of fat can also **hinder cross-linking between amylose** and thus **retard retrogradation**

Exercise : Prepare the flour alone and with additives by using the following procedure and record the temperature of gelatinization and time taken for both gelatinization and retrogradation .

Procedure:

- Weigh Twenty five grams of rice flour and cook it in 300 ml water with different additives viz, sugar, fat and acid. Heat it until gelatinization took place.
- Record Gelatinization temperatures, time taken for completion of gelatinization along with retro gradation.

Observation:

Flour with Additives	Temperature	Time Taken in minutes	
		Gelatinization	Retrogradation
Rice flour	94^0 C	3.33	5.10
Rice flour +Sugar	91 ^{0} C	5.50	11.16
Rice flour +Citric Acid	95 ^{0} C	5.49	10.19
Rice Flour + Fat	86 ^{0}C	3.40	12.11

Result and discussions:

The experiment has to be conducted by adding different additives- Sugar, citric acid and fat to rice flour. The rice flour to be cooked by adding sufficient amount of water. The time taken and the temperature for gelatinization and retro gradation has to be noted.

In the experiment with rice flour alone, the time taken for both gelatinization and retro gradation has to be noted and compare it with other treatments with additives and find out the temperature variations. What happens when is sugar is added? Has sugar delayed the time for gelatinization? Is this delay in gelatinization in a sugar solution, is mainly due to the ability of sugar to the following attributes. Explain?

- Limited water availability to the starch granules.
- Lower water activity
- Form sugar bridges between starch chains.

Inference:

Attribute scientific commentary on the effects of additives on carbohydrate with supportive studies.

Exercise 6

Effect of Cooking and Processing on Plant Pigment

Introduction

- Chlorophyll. Chlorophyll, the green pigment of plants, plays an important role in their synthesis of carbohydrates.
- The cells of the mesophyll of the leaf contain chloroplasts or chlorophyll-corpuscles, the nucleus, other substances, and the cell liquid with its dissolved materials.
- The chloroplasts contain four pigments, two green ones, chlorophyll a and chlorophyll b, and two yellow ones, carotene and xanthophyll.
- Solubility of chlorophyll.
- Chlorophyll is not soluble in water. Very little green color is found in the water in which green vegetables have been cooked.
- Pure isolated chlorophyll is soluble in acetone, ether and benzene.
- In extracting the pigment from thoroughly dry leaves it is necessary to add about 20 per cent of water to the acetone or other solvent.
- One explanation for this is that chlorophyll is in the colloidal state in the leaf, and the mineral constituents of the leaf, dissolved in the water, peptize it, rendering it soluble.
- Onslow states that "the condition of chlorophyll is altered by plunging into boiling water.
- The pigment is then much more soluble, in ether, etc., even when the leaves are subsequently dried.
- It is supposed that the chlorophyll has diffused out from the plastids, and is in true solution in the accompanying waxy substances which have become liquid owing to change in temperature."

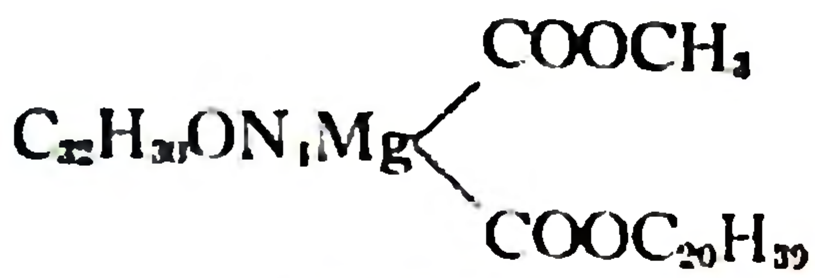
During Boiling

- When green vegetables are dropped into boiling water a change takes place nearly instantly, the green color being intensified.
- Various explanations have been offered for the phenomenon.
- One is that the hot water has melted waxy constituents of the leaf so the chlorophyll escapes from the cell more readily or may become more soluble.
- Or the hot water may have dissolved salts or other substances in contact with the chlorophyll so that it diffuses more readily.
- For peas, one factor in the **intensification of the green color is the removal of air from the pea** when it is dropped in the boiling water.
- The outer skin of the pea is transparent, the space beneath this being impregnated with air which is removed when the peas are blanched.
- That this change in color is caused by removal of the air can be shown by subjecting the peas to an **adequate vacuum under cold water and releasing the vacuum while the peas are still under the water.**

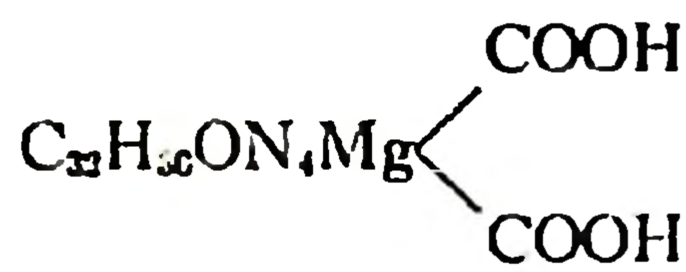
Special Features

Composition of chlorophyll

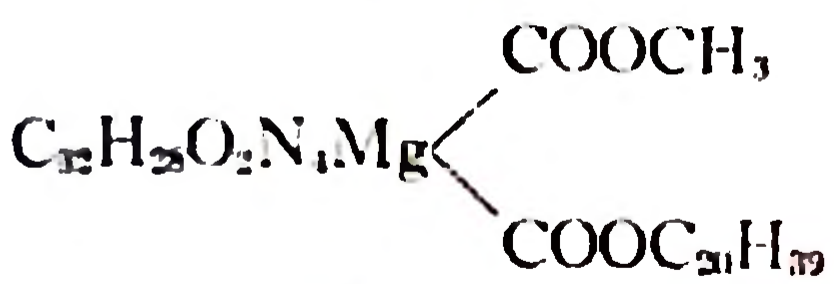
- The chemical reactions of chlorophyll, reports that it exists in two forms, depending upon the **degree of oxidation in the plant cells: form (a) and form (b)**. The former exists in the proportion of three to one of the latter.



chlorophyll a



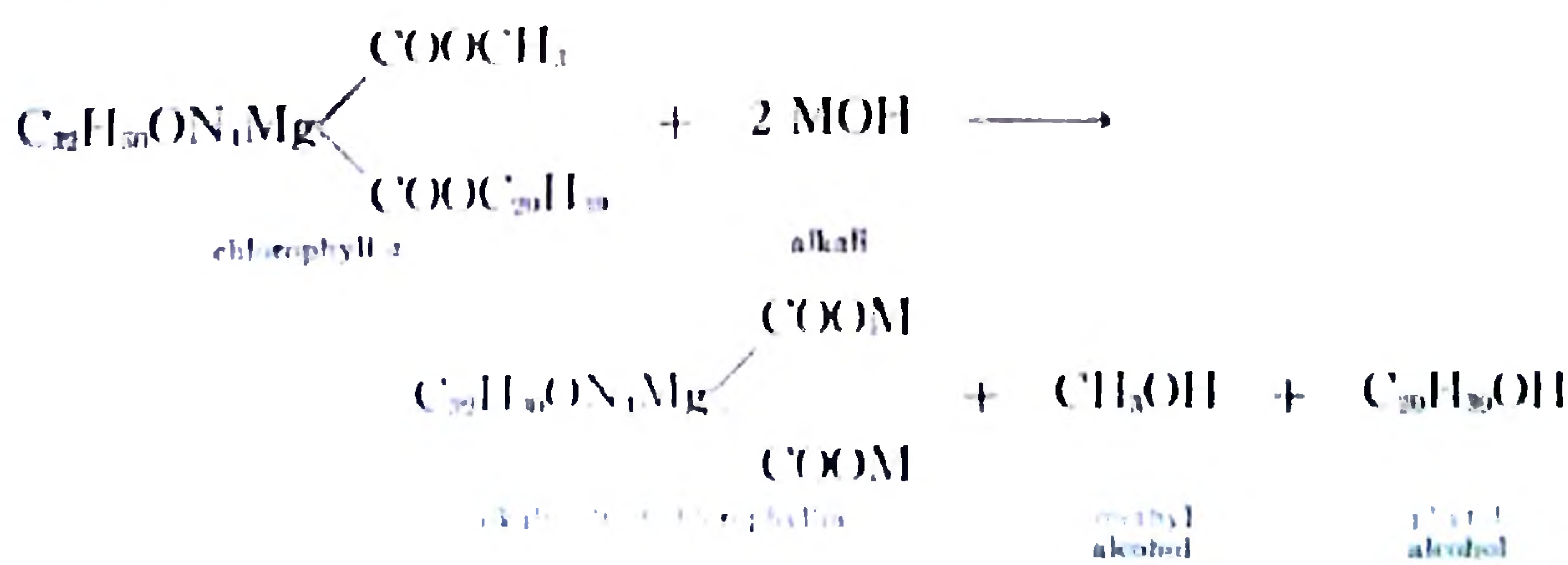
chlorophyllin



chlorophyll b

Chlorophyll contains **2.7 %** of the metal **magnesium**. It contains **two ester** groups, one of **methyl alcohol (COOCH3)** and one of **phytol alcohol (COOC20H39).**

- Reactions of **chlorophyll with alkalis**
- **Chlorophyll is a neutral** substance but gives **characteristic reactions** when treated with **alkalies or acids**.
- The **parent** substance of chlorophyll as **chlorophyllin.**
- The reaction of **chlorophyllin** with **methyl** and **phytol alcohols** gives the **ester chlorophyll**.
- Chlorophyll, when treated in the **cold with alkalies,** gives **alkaline salts of chlorophyllin.**
- The color change is **first brown**, followed by a return of the **green**, but it is **no longerfluorescent.**
- When chlorophyll is **saponified** with **hot alcoholic** alkalies, **isochlorophyllins** are formed, which are **fluorescent**.



- **When the green-colored vegetables are cooked in water with an alkaline reaction, or in water to which a small amount of soda is added, they develop a bright, intense green color.**

Reaction of chlorophyll with acids.

Chlorophyll reacts with **acids** to give an **olive-colored** product, without fluorescence, called **phaeophytin.**

The **magnesium** of the **chlorophyll** is **replaced by hydrogen.**

From **phaeophytin** -has obtained two decomposition groups:

1. **Phytochlorins**, are **olive green** and derived from **chlorophyll A**

2. **Phytorhodins**, are **red** and derived from **chlorophyll B.**

$$\underset{\text{chlorophyll a}}{C_{32}H_{30}ON_4Mg\begin{cases} COOCH_3 \\ COOC_{20}H_{39} \end{cases}} + \underset{\text{acid}}{2\,Hx} \longrightarrow$$

$$\underset{\text{phaeophytin}}{(C_{32}H_{32}ON_4(COOCH_3)(COOC_{20}H_{39}))} + \underset{\text{magnesium salt}}{Mgx_2}$$

The <u>effect of heat</u> upon chlorophyll.

The **chlorophyll** is changed to the **olive-green** color by two means,
(1) **Hydrogen ions or an acid** reaction and
(2) **Heat**.

- The **hydroxyl ions, or an alkaline** reaction, produce**chlorophyll salts with bright green color.**
- **In general, the more acid the reaction, the more rapid is this change in color when the vegetable is heated.**
- **The more alkaline the reaction, the more slowly the chlorophyll changes to olive-green.**
- **Thus in order that the bright green color be retained in cooking green vegetables, they should be cooked for as <u>short a time</u> as possible and <u>contact with acids should be avoided</u> as far as possible.**
- It is also possible that other **ions than the hydrogen and hydroxyl ions may affect the stability of the chlorophyll.** for some vegetables with nearly the same pH, cooked in water from the same source, and with other conditions standardized are more stable to heat than others.
- In cooking certain procedures may aid in decreasing the acidity of the cooking water.
- The vegetables contain **both volatile** and **non-volatile acids**, which in the plant are **prevented from uniting with the chlorophyll** but are liberated when the **plant** tissues are **heated**.

- **If the cooking vessel is not covered, the volatile acids may escape with the steam, thus decreasing the acidity.**
- **It has been found that the highest percentage of these volatile acids passes off during the first few minutes of cooking.**
- **Hence, if the cooking vessel needs to be covered for a part of the time, it is preferable to have the uncovered period the first few minutes.**
- **Hard** water, **softened** water, or water from many **streams**, is **alkaline** in reaction.
- **Rain** water, **snow**, or **ice** water is usually about **neutral**.
- If the cooking **water contains alkaline salts**, these salts may **neutralize the non-volatile** acids, and if there is a slight **excess of alkaline salts** the **green color** is intensified.
- To a certain extent the **intensification** depends upon the **quantity of water** used, for the **larger quantity** of water contains a **greater quantity of alkaline** salts.
- If the **water** is only slightly **alkaline** the **plant acids** may not all be **neutralized** and the **olive-green** color may develop.
- If the **water is very alkaline** and **considerablewater** is used, not enough **volatile** and **non-volatile acids** will be liberated to **neutralize the alkalinity of the water**, the **cover** can be **kept on during cooking**, and the product will be **bright green**.
- With **longer cooking the heat** may have more effect upon the **chlorophyll** than the **alkaline salts of thewater**.
- The addition of **sodium bicarbonate (baking soda)** also **intensifies the green color**.
- Canned spinach, asparagus, peas, and string beans have a **deep olive-green** color due to the **retention of the plant acids** during **processing and to the high temperature at which they are processed.**
- Green vegetables like cabbage, Brussels sprouts, and spinach cooked in **milk** may remain a bright green color.
- Owing to the ease with which **milk scorches** and **boils over** there is usually **less tendency to cook the vegetablestoo long when milk is used**.
- **Mineral salts of organic acids** may be formed during the cooking of **fruits** in **metal** containers.
- Very unpalatable **flavors** are developed in this way, and the color of the cooked product is darkened.

Thus oxalic acid gives

$$\underset{\text{oxalic acid}}{\begin{array}{c}COOH\\ |\\ COOH\end{array}} + \underset{\text{potassium hydroxide}}{KOH} \longrightarrow \underset{\text{water}}{H_2O} + \underset{\text{acid potassium oxalate}}{\begin{array}{c}COOK\\ |\\ COOH\end{array}}$$

$$\underset{\text{oxalic acid}}{\begin{array}{c}COOH\\ |\\ COOH\end{array}} + \underset{\text{potassium hydroxide}}{2\ KOH} \longrightarrow \underset{\text{water}}{2\ H_2O} + \underset{\text{potassium oxalate}}{\begin{array}{c}COOK\\ |\\ COOK\end{array}}$$

Zinc utensils.

- Some of the metal salts formed with **organic acids** are **injurious** when taken into the **body**.

- The **zinc salts of organic acids have been regarded as toxic.**

- They are formed when foods containing acids are placed in **galvanized containers**.

- **Galvanized iron contains** some zinc, and when fruits, beverages, or even **milk** are placed in utensils made of it, the **acids of the food combine with the zinc, forming salts.**

- Zinc is dissolved from galvanized utensils and the greater the acidity of the food and the **longer the food stays** in such containers the more zinc dissolved.

- Even fresh milk contains enough acid to dissolve appreciable amounts of zinc.

- The toxicity of buttermilk held in galvanized containers. question the attributing of the toxicity to zinc in many previous investigations

- The toxicity may have been due to the surface of **the galvanized container being contaminated with some other substance, possibly arsenic, lead, or antimony.**

- The **tin** salts have not been found poisonous, but large amounts of them in a food, such as **would result when an acid fruit is cooked for a long time in a tin wash boiler, produce a very dark color and a disagreeable metallic flavor.**

- **Iron salts** with acids may cause **discoloration** in some food products.

Effect of cooking food with baking soda

- Cooking food with baking soda (a.k.a. sodium bicarbonate) can indeed **damage a number of nutrients, such as vitamin C, vitamin D, riboflavin, thiamine, and one essential amino acid.** Yet **it doesn't hurt others, including vitamin A, vitamin B12, niacin, and folic acid.**

- However, that alkalinity usually gets neutralized during cooking by the small amounts of acid in many fruits and vegetables.
- Professional cooks have known that adding bicarbonate of soda to cooking vegetables enhances their color; greens turn bright green and old carrots look like new.
- It's a chef's trick that has crept into some recipe collections and often appears

  in lists of cooking tips and hints. It is not a good practice.

Aim:

To study the effect of cooking and processing on plant pigment.

Characteristics:

- Vegetables are plant or part of plants served with the main courses of a meal.
- Apart from this nutritive value, vegetables probably do more than any other group of food, to add appetizing colour, texture and flavours to daily food.
- Cooking affects the colour, texture and nutritive value of vegetables. Cooking methods can destroy good qualities if not handled properly.
- Common method of cooking is boiling, steaming, baking, drying and pressure cooking.
- Before applying this method the chemical structure of vegetables must be considered.
- Vegetables contain different chemical compounds like pigments, tannins, enzymes and flavouring substances.
- Common pigments in vegetables are chlorophylls, carotenoid, flavonone and anthocyanins.
- **On heating these pigments undergo certain chemical changes which affect the colour of the finished product.**
- Vegetables also loose organic acids and nutrients in cooking water.
- Acid or alkali contents and cooking media also affect the appearance and quality of the product.
- At a high temperature cellulose is disintegrated and proto pectin, a non-dispensable substances in water undergoes hydrolysis, make it dispensable.
- This change the structural frame work of the vegetable becomes mushy and unpalatable and exert an antiplasticizing effect, relative to water.
- Starch**retrogradation**is one of the undesirable processes which occur during the storage of starchy foods. Many additives can be used to retard retro gradationof starch in foods. When compared to the additives used in the experiments, **fat showed**
- **delay in retro gradation**. During retro gradation, **amylose** is more **easily**

retrograded. The addition of fat in starch-water systems can hinder water penetrations into granules and hinder amylose leaching during heating.
As a result, the mobility of amylase molecules is constrained, resulting in slow retrogradation.
Addition of fat can also **hinder cross-linking between amylose** and thus **retard retrogradation**.Since vegetables lose this natural flavour on cooking.

ım bicarbonate is added to some vegetables to help in retaining the green colour and n cooking. This method of cooking results in **heavy lose of many vitamins** due to the : of **alkaline pH** and when **vinegar or citric acid** are added to vegetables before cooking the **vegetables does not cook readily** and remain **firm and hard**.

Exercise:

- **Follow the following procedure for cooking various vegetables.**
- **Observe and record effect of cooking time**
- **Observe and record effect of various cooking medium.**

Procedure:

General Instruction:

1. Boil water before adding the vegetables, and boil the vegetables at the quickest time as possible.
2. Cover the pan while cooking.
3. Use 25gm of vegetable and one cup of water.
4. Measure the left over water.
5. Use carrot, beans, cabbage and potatoes.

Method:

1. Effect of cooking time: remove all vegetables (5g) after 5 minutes.
2. Effect of cooking medium.
   a). Boil vegetable in water after adding ½ teaspoon of cooking soda.
   b). Boil vegetables in water after adding 1 teaspoon vinegar.
   c). Boil vegetable in water after adding ½ teaspoon of salt.

Observation:

Vegetables	Without Salt	Salt	Acid	Alkali
Carrot	Pale yellow, fade	Bright, No fade	Yellow hard	Colour retain soft
Beans	No change in colour	Light change, Light green	Colour fade hard.	Bright green soft
Potato	White, normal texture	Creamy white in colour.	Dull white colour	Bright white soft.
Cabbage	No change in colour	Light white soft	Dull white hard	Creamy white

Vegetables with additives	Water taken initially and remained after blanching (ml)		Vegetables with additives	Water taken and remaining after blanching (ml)	
	Before	After		Before	After
Carrot			**Cabbage**		
Water	280	180	**Water**	150	16
Salt	150	130	**Salt**	150	25
Acid	150	80	**Acid**	150	9
Alkali	150	6	**Alkali**	150	45
Beans			**Potato**		
Water	150	100	**Water**	150	65
Salt	150	100	**Salt**	150	70
Acid	150	80	**Acid**	150	50
Alkali	150	30	**Alkali**	150	25

Result and discussion

- Observe and record the appearance of the vegetables cooked in alkali and salt. Isit good or bad?.
- What are the effect of water and other medium?Is it a light change or extreme change in plant pigments?
- What are the effect of water, salt, acid, alkali in the colour pigments?
- Why do the colour changed with acid?
- Explain about the changes in the texture in the various vegetables cooked in water, salt, acid, and alkali?
- Measure the left out water-amount in ml and compare it for each treatment with water, salt, acid,alkali treatments.

Inference :

Attribute scientific aspects of effect of cooking and processing on various plant pigments with supportive studies.

Exercise 7

Effect of cooking on Protein Content of Foods

Introduction:

- Processing by **heat** increases **food digestibility** because it **breakdown** the food to complex proteins and carbohydrates.
- Despite this, however, vitamins, minerals, some essential amino acids, and other beneficial nutrients are lost.
- **Lipid** oxidation is one factor that contributes to loss of **protein quality**.
- The protein quality of is affected during processing as a result of the application of heat, which causes protein **de-maturation**.
- The extent of protein de-maturation depends on type of **cooking method**, the **duration** and **temperature**.
- Heat treatments changed the protein molecular structure. Both dry and moist heating increased the amide I-to-amide II ratio.
- Compared with dry heating, moist heating dramatically changed the chemical and nutrient profiles
- It greatly decreased soluble crude protein, non-protein nitrogen, and increased neutral detergent insoluble protein.
- Both dry and moist heating treatments did not alter digestible nutrients and energy values.
- Heating tended to decrease the non-protein nitrogen fraction (soluble and rapidly degradable protein fraction) and true protein 1 fraction (fast-degradable protein fraction). Conversely, the true protein 3 fraction (slowly degradable fraction) significantly increased.
- Compared with dry heating, moist heating dramatically affected the nutrient profile, protein sub-fractions, rumen degradability, intestinal digestibility, and protein molecular structure (amide I-to-II ratio; α-helix-to-β-sheet ratio) in various studies.

Special Features

- To cook eggs at a temperature between **70°C/158°F** and 84.5°C/184°F, so that the co albumin and ovomucoids (but not the ovalbumin) will be denatured, for a time to heat the yolk to a temperature around 64.5°C/148°F, yielding a soft-boiled egg with a firm by not rubbery egg white.
- When egg white is subjected to heat, its globular proteins are prone to changes in structure and conformation.
- Depending on the extent of the temperature and duration of the treatment, these changes can range from denaturation at the gelation or coagulation.
- **Temperature** of coagulation for whole **egg**, **egg white** and **egg** yolk differs.

- **Denaturation** refers to the physical changes that take place in a **protein** when exposed to.
- **Heat** treatment of eggs causes **denaturation** of their key proteins **ovalbumin and ovomucoid,** leading to a **decrease in allergenicity.**
- **Cytokine** production indicating a **shift from a type 2 cytokine response to a type 1 response** was observed in **heat denatured ovalbumin and ovomucoid** stimulatedcells.
- The **strong decrease** in solubility at **higher temperatures (74-89 °C)** is probably due to **denaturation** and **aggregation** of **heat-resistant** proteins such as **ovalbumin.**
- **Ovalbumin** is an almost spherical **glycophosphoprotein** which is the most common protein in egg white, representing nearly **60 %** of the whole. The peptide chain consists of 385 amino acids (MW = 42,700 Da). Hydroxyl groups from the side chains of serine-68 and serine-344 are esterified with phosphoric acid, and an oligosaccharide is attached to the side chain of asparagine-292.
- **Ovotransferrin**, constituting **13 %** of the egg white, consists of 686 amino acids (MW = 77,000 Da), and may bind two iron- or other multivalent-metal-cations. This bonding involves two phenolic hydroxyl groups (from tyrosine) and a nitrogen atom (on histidine). Strong binding with iron inhibits the growth of microorganisms (as well as *Salmonella enteritidis*) in the yolk, a process that requires a constant influx.
- **Ovomucoid**accounts for **11 %** of the **protein** content of **egg white**.It occurs in various forms, which differ in the amount of carbohydrate bonded via asparagine. Nine disulfide bridges and a high content (< 80 %) of helical and β-pleated sheet structures confer upon ovomucoid such a stable spatial structure that it is not denatured even upon boiling.
- **Ovomucin** is a relatively small protein (MW = 10 kDa) to whose amino acid chain a wide variety of carbohydrate entities (glucosamine, glactosamine, hexoses, scialic acid) are bound, and a substantial portion of whose hydroxyl groups are esterified with sulfuric acid. Due to its polar character, ovomucin aggregates to **filamentous** and **fibroid** structures.The **high viscosity** of the **egg white** layers is a consequence of a **high ovomucin** content.

- **Lysozyme** is one of the most thoroughly investigated of all proteins and was the very first protein subjected to X-ray structural analysis. As implied by its name, it is an **enzyme**, one found in other animal tissues and secretions as well. It cleaves specific bonds in specific polysaccharides, ones that constitute the cell walls of many **bacteria. Lysozyme thus has antibacterial activity,** and provides an embryo with a measure of protection against infection during its developmental phases.

- Both egg yolks and whites are excellent sources of standard protein with high BV and PER ratio. However, the nutritional value including the amount of protein differs between the yolks and whites of eggs

- Regardless of whether you choose the yolk, egg white or whole eggs, adding eggs to your diet can help you meet your daily protein needs. One whole egg contains about 6 grams of protein.
- **Egg-white** proteins are **long molecules**, made up of chains of **amino acids** linked together.
- In a **raw egg**, these proteins are **curled** and folded to form a **compact ball**.
- When you **cook an egg**, these proteins **uncurl** and form new **bonds** with one another.
- The **longer** you heat the **proteins** and the higher the temperature, the **tighter** the proteins will bond to each other.
- The **tightness** of these bonds determines whether the eggs are cooked just **rightor overcooked**.
- Heat the eggs slowly, making for **loose bonds** among the proteins and **tender**, rather than **rubbery**, egg whites.
- Heat around **145°F** for **egg white** and **150°F** for **egg yolk**.
- Continuedheating causes **more bonds** to form, leaving **less space** for the **water**.
- Eventually, much of the water is squeezed out (this is referred to as **weeping**) and **evaporates**, causing the egg protein to **coagulate**.
- Reaction is prevented by immediate cooling of the egg (e.g. immersing in cold water) after cooking.
- Coagulation of proteins: **white at 60-65^{0}C, yolk at 65-70^0 C.**
- Beyond this temperature, **over coagulation** occurs and **water** is **squeezed** out causing **shrinkage** resulting in a **tough** product.
- **Cooking transforms no other food as dramatically as an egg.**
- Whether you prefer them **hard-cooked, poached, fried, or scrambled**, knowing how eggs go from raw to cooked can help **you perfect** your **technique**.
- **What happens when we cook eggs?**
  - The yolk and white (albumen) of raw eggs are essentially just sacks of water dispersed with proteins-about 1,000 water molecules to every one protein molecule.
  - Protein molecules are relatively enormous, composed of hundreds of amino acids bound together into long chains.
  - In a raw egg, the chains are folded into compact globs held together by fairly weak chemical bonds connecting the folds.
  - Due to the chemistry of egg albumen, most of the **protein** globs in the **white** have **a negative electrical charge** and therefore **repel** each other, which keeps the white watery and loose.
  - In the yolk, some of the proteins are bound up with **fat**, so although some yolk proteins repel each other, the electrical charge of others is **neutralized** by their **fat** coating, which makes **yolk proteins less repulsive to one another.**
  - **That's why a raw yolk, though still liquid, is less runny than a raw egg white.**

n:

determine the effect of coagulation at different temperature on the texture and /ours of egg white and yolk cooked in shells.

aracteristics:

- Eggs are used in many preparation due to variety, they provide food.
- Nutritive importance, flavour, pleasing colour, thickening powders, foam forming ability, emulsifying capacity, stabilizing capacity and the binding property of egg are utilized in menu planning.
- When heated various proteins coagulates at different temperature.
- The egg is rich in protein.
- It is easily coagulated by heat.
- Egg white startscoagulationat 52^{0} Cand the coagulation of egg yolk begins at 65 ^{0}C is completed at 75 ^{0}C.
- Soft cooked and hard cooked egg are those prepared in the shell.
- The criteria for a soft cooked egg and that the white should be firm, but tender and yolk a thick liquid.
- In hard cooking of egg, the white becomes an opauc, tender gel and the yolk is completely coagulated.

  Exercise:

  - **Cook egg in boiling water for 3,6,10,15 minutes and put them in cold water as per the following procedure and observe changes in various criteria-appearance, texture, taste, firmness, flavour etc.and record the changes.**
  - **Cook for 15 minutes and observe and record the changes when eggs are transferred to cold water and left in cooked water (different conditions).**
  - **Cook it for 30 minutes in low temperature and put in cold water and observe and record the changes in various criteria.**

cedure:

Cooking an egg in boiling water for 3 minutes.

Cook an egg in boiling water for 6 minutes

Cook an egg in boiling water for 10 minutes- cool all these three rapidly in water.

Cook an egg starting with cold water for 15 minutes and then put in cold water.

Cook two eggs in boiling water for 5 minutes and transfer one immediately into cold er. Cool the other one slowly leaving in the cooked water

Cook an egg for 30 minutes at simmering temperature, put it in cold water.

Observation:

CRITERIA	SCORE	3 MIN	6 MIN	10 MIN	START WITH COLD WATER FOR 15 MIN & PUT IN COLD WATER.	COOK FOR 15 MIN		COOK FOR 30 MIN IN SIMM. TEMP& PUT IN COLD WATER.
						COLD WATER TRANSFER	LEFT IN COOKED WATER	
Appearance								
Good	3							
Fair	2	1	2	3	3	3	3	1
Poor	1							
Texture								
Hard	3							
Soft	2	1	2	3	3	3	3	1
Turbid	1							
Firmness								
Very firm	3							
Firm	2	1	2	3	3	3	3	1
Not firm	1							
Taste								
Good	3	1	2	3	3	3	3	1
Fair	2							
Poor	1							

Result and discussion:

- Explain the results when egg is cooked under different temperature and at varying times for 10 minutes and 15 minutes gave good appearance compared to eggs cooked at 3, 5, 30 minutes.

- Was egg cooked at 10 and 15 minutes gave good results about its' texture, firmness and taste ?
- What was the result at 3 minutes and 30 minutes?
- Do you observe poor result?
- Do you observe any moderate result when eggs are cooked at 5 minutes?
- Explain about the various changes and coagulations occurred during cooking of eggs at varied rate of temperatures?

Inference:

Attribute scientific aspects of effect of cooking on protein content of food with supportive studies.

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Exercise 8

Determination of Gluten content of Foods

Introduction

- High gluten flour and bread flour is produced from hard wheat.
- High gluten flour has a gluten percentage of about **12-14%** while bread flour contains about 10-13% gluten.
- Both flours are almost completely made of hard wheat, but some high gluten flours are treated to reduce starch content, raising the gluten content to around **14%.**
- These flours are generally used for making breads.
- **High gluten flour** is reserved for breads that are extra elastic such as **bagels** and **pizza**.
- **Cake flour** is produced from **soft wheat** and is **low in gluten** content **(8-10%).** This flour is used for making delicate cakes.
- Baked goods made with cake flour have a tendency to crumble because of the low gluten content.
- **All purpose flour** is made from a mixture of hard and soft wheat.
- The **gluten** content ranges from **9-12%.** This is the most versatile flour because it can be used to make both cakes and breads. However, breads won't be as chewy and cakes won't be as tender as if you used bread or cake flour.
- **Pastry flour** is also a mix of **hard** and **soft** wheat flours with an emphasis on soft. Generally, the gluten content is **9-10%** and is often recommended for **pie crusts.**

Special Features:

- **The Gluten-Hand washing Method.**
- This testing is approved by AACC (American Association of Cereal Chemist
- **Procedure:**
- Weigh 25 g of flour into a cup and add sufficient water to form a firm dough.
- Start with 10 ml water and gradually increase until a firm dough is developed.
- Hand knead dough and incorporate fines into a ball.
- Record the amount of water you add.
- Let the dough stand in water at room temperature 20-60 min.
- Washing may become easier with increased soaking time.
- Soft wheat flour are easier to wash if soaking time does not exceed 20 minutes.
- Knead dough gently in stream of tap water over cloth until starch and all soluble matter are removed.
- When much of the starch has been removed, the gluten ball will become darker and will take on a weblike structure.
- This generally takes 20-30 minutes.

- **To determine whether gluten is approximately starch-free.**
- **Let 1 or 2 drops of water, obtained by squeezing, fall into a see thru glass containing perfectly clear water.**
- **If starch is present, cloudiness appears.**
- Let gluten thus obtained by washing stand in water 1 hr.
- Press as dry as possible between the hands, roll into a ball , place in a dish and weigh it as moist gluten (wet gluten)
- Hard flours with high protein contents9 (14% protein) - would have a roughly estimate wet gluten of 35-38% while soft flours ranges from 24-28%.

Aim:To determine the gluten content ofwheat flour, Corn flour, refined wheat flour.

Exercise: Prepare the dough as per the following procedure, observe the gluten formation and record it.

- **Procedure:**
- Weigh 100 g of each flour and make it as a batter.
- Tie in muslin cloth and wash with water until the water becomes clean.
- Take the final residue (Wet Gluten) and dry it in a hot air oven.
- Weigh the dried gluten.

Observation:

Cereal flour	Weight of gluten (g)
Wheat flour	11.11
Refined wheat flour	10
Corn flour	7.8

Result and discussion

Gluten is a protein composite found in several types of grain. Gluten consist of two protein-gliadin andglutenin.It is gliadin part that people react negatively too. When the flour is mixed with water,gluten forms a sticky cross –linked net work of protein,giving elastic properties to dough and allowing bread to rise when baked.The name of gluten is derived from these glue like properties. Do the refined wheat flour has low gluten content, as compared to the gluten content of wheat flourand corn flour.Gluten is a protein found in wheat, barley, rye, and triticale, a combination of wheat and rye. It helps foods such as cereal, bread, and pasta, to hold their shape.

Inference: Attribute scientific aspects of determination of gluten content in foods with supportive studies.

Exercise 9

Effect of Cooking on the fat content of Foods

Introduction:

- Nutrient loss is a consequence of nearly every cooking process.
- Exposure to heat, light or oxygen will alter the nutrients found in food, and methods that involve water often reduce the amounts of nutrients as these get 'washed out' and left behind.
- However, cooking foods also has its advantages, including a reduction of the number of possible malignant microbes, an increase in digestibility and the increased availability of certain phytonutrients.
- **Heating affects** mostly the vitamin and **fat** content of foods, as well as the texture that they present.
- Some **fats** are able to tolerate **higher** temperatures than others, before reaching their **'smoke point'**, at which their chemical structure is modified.
- These **changes** have been associated with **health risks**, **unpleasant odours, impairedflavour and reduced vitamin** content.

Special Features:

- The **smoke point** also known as **Burning point** of an **oil or fat** is the temperature at which, under specific and defined conditions, it begins to produce a continuous bluish smoke that becomes clearly visible.[1]
- **Smoke point values** can vary greatly, depending on factors such as the **volume** of oil utilized, the **size** of the container, the **presence of air currents**, the **type** and **source** of light as well as the **quality** of the oil and its **acidity** content, otherwise known as **free fatty acid (FFA)** content.[2]
- The more **FFA** oil contains, the **quicker** it will **break down** and start **smoking**.[2][3]
- The **higher** in **quality** and the **lower** in **FFA**, the **higher** the **smoke point**.[4]
- It is important to consider, however, that the FFA only represents typically less than 1% of the total oil and consequently renders smoke point a poor indicator of the capacity of a fat or oil to withstand heat.[4][5][6]
- The **smoke point of an oil correlates with its level of refinement**.[7][8]
- Many cooking oils have smoke points above standard home cooking temperatures:

- **Standard Cooking Temperatures**[9]

Pan frying (sauté) on stove top heat: 120 °C (248 °F)

Deep frying: 160 - 180 °C (320 °F - 356 °F)

Oven baking: Average of 180 °C (356 °F)

- **Smoke point decreases at different pace in different oils.**[10]
- **Considerably above the temperature of the smoke point is the flash point, the point at which the vapors from the oil can ignite in air, given an ignition source.**
- **Oxidative stability**
- Hydrolysis and oxidation are the two primary degradation processes that occur in an oil during cooking.[10]
- Oxidative stability is **how resistant oil** is to reacting with oxygen, breaking down and potentially producing harmful compounds while exposed to continuous heat.
- **Oxidative stability is the best predictor of how an oil behaves during cooking** .[11][12][13]
- The Rancimat® method is one of the most common methods for testing oxidative stability in oils.[13]
- This determination entails speeding up the oxidation process in the oil (under heat and forced air), which enables its stability to be evaluated by monitoring volatile substances associated with rancidity.
- It is measured as "**induction time**" and recorded as total hours before the oil breaks down.
- Canola oil requires 7.5 hours, for example, whereas extra virgin olive oil (EVOO) and **virgin coconut** oil will last over a day at 110 °C of continuous heat.[9]
- The differing stabilities correlate with lower levels of **polyunsaturated fatty acids**, which are more **prone to oxidation**. EVOO is high in **monounsaturated fatty acids and antioxidants, conferring stability.**[9]
- **The following table presents smoke points and oxidative stability of various fats and oils:**

Fat	Quality	Smoke Point	
Almond oil		221°C	430°F[14]
Avocado oil	Refined	270°C	520°F[15][16]
Mustard oil		250°C	480°F[17]
Butter		150°C	302°F[18]

Fat	Quality	Smoke Point	
Butter	Clarified	250°C	482°F[19]
Canola oil		220-230°C[20]	428–446°F
Canola oil (Rapeseed)	Expeller press	190-232°C	375-450°F[21]
Canola oil (Rapeseed)	Refined	204°C	400°F
Canola oil (Rapeseed)	Unrefined	107°C	225°F
Castor oil	Refined	200°C[22]	392°F
Coconut oil	Refined, dry	204°C	400°F[23]
Coconut oil	Unrefined, dry expeller pressed, virgin	177°C	350°F[23]
Corn oil		230-238°C[24]	446-460°F
Corn oil	Unrefined	178°C[22]	352°F
Cottonseed oil	Refined, bleached, deodorized	220-230°C[25]	428–446 °F
Flaxseed oil	Unrefined	107°C	225°F[16]
Lard		190°C	374°F[18]
Olive oil	Refined	199-243°C	390-470°F[26]
Olive oil	Virgin	210°C[22]	410°F
Olive oil	Extra virgin, low acidity, high quality	207°C	405°F[16][9]

Fat	Quality	Smoke Point	
Olive oil	Extra virgin	190°C	374°F[9]
Olive oil	Extra virgin	160°C	320°F[16]
Palm oil	Difractionated	235°C[27]	455°F
Peanut oil	Refined	232°C[16]	450°F
Peanut oil		227-229°C[16][28]	441-445°F
Peanut oil	Unrefined	160°C[16]	320°F
Rice bran oil	Refined	213°C[29]	415°F
Sesame oil	Unrefined	177°C	350°F[16]
Sesame oil	Semirefined	232°C	450°F[16]
Soybean oil		234°C[30]	453°F
Sunflower oil	Neutralized, dewaxed, bleached & deodorized	252-254°C[31]	486–489°F
Sunflower oil	Semirefined	232°C[16]	450°F
Sunflower oil		227°C[16]	441°F
Sunflower oil	Unrefined, first cold-pressed, raw	107°C[32]	225°F
Sunflower oil, high oleic	Refined	232°C	450°F[16]
Sunflower oil, high oleic	Unrefined	160°C	320°F[16]
Vegetable oil blend	Refined	220°C[9]	428°F

Aim: To determine the effect of heat on different oil.

Characteristics:

- Fats and oils are combination of glyecerol and fatty acids.
- Fat gradually soften on heating.
- They do not have a sharp melting point.
- Since fat can be heated above the boiling point of water.
- They can brown the surface of theoil.
- Smoke point of a fat is the temperature at which smoke come continuously from the surface of fat.
- Because fat differs on their smoke point,fat to be used for frying should be chosen on the basis of their resistance to the smoking at the temperature used.

Exercise: Find out the Smoke Point of different oils as per the following procedure.

Procedure:

- Take 15 g of coconut oil, sunflower oil, gingerly oil,
- Allow it to heat.
- Find out the smoke point of those oils using s thermometer.

Observation:

Oil	Smoke Point
Coconut oil	
Sunflower oil	
Gingerly oil	

Result and discussion:

- The smoke point of an oil is the temperature at which various volatile compounds emerge when a bluish smoke become clearly visible from the oil.
- At this temperature, the volatile compounds such as free fatty acids and short chain degradation-products of oxidation come out from the oil..
- The smoke point is the temperature limit up to which that cooking oil can be used .

Inference:

Attribute scientific aspects of the effect of cooking on the fat content of food with supportive studies.

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Exercise 10

JACK FRUIT SEED FLOUR CHOCOLATE

Introduction:

- The jackfruit (**Artocarpus heterophyllus**), also known as jack tree, fenne, jakfruit, or sometimes simply jack or jak, is a species of tree in the fig, mulberry, and breadfruit family (Moraceae) native to southwest India.
- Jackfruit is a species of tree which belong to Moraceae family. Ripe fruit is naturally sweet with subtle flavouring. It can be used to make a variety of dishes including custards, cookies etc.
- The seeds from ripped fruits are edible and have a milky sweet taste often comparable to the flavour of chestnut when roasted.
- They can be boiled, baked or roasted.
- The protein found in jackfruit seed is said to have more hydrophilic subunit structure and this could be the reason for higher water absorption by jackfruit seed flour.
- Jackfruit seed flour have several compounds which give chocolate in distinctive aromas such as caramel, hard nut or fruity.
- Roasted jackfruit seed flour impart an aroma similar to that of chocolate and thus they serve as a potential replacement for cocoa beans for the manufacture of chocolates.

Characteristics:

- Flour from jackfruit seed was prepared by dry milling.
- It is high in protein and carbohydrate contents.
- The flour has good water and oil absorption abilities.
- <5% of wheat-flour can be replaced with jackfruit seed flour for making white bread.
- Its amylose content was high.
- The starch showed good paste stability during heating and gave the A-type X-ray diffraction pattern.

Special features

- Some physicochemical and rheological properties of jackfruit seed flour and starch, isolated from the flour were investigated.
- The flour had good capacities for water absorption and oil absorption (93%).
- Substitution of wheat flour with the seed flour, at the level of 5, 10 and 20% markedly reduced the gluten strength of the mixed dough.

- The edible bulbs of ripe jackfruit are consumed fresh or processed into canned products.
- Seeds make-up around 10 to 15% of the total fruit weight and have high carbohydrate and protein contents.
- Seeds are normally discarded or steamed and eaten as a snack or used in some local dishes.
- As fresh seeds cannot kept for a long time, seed flour can be an alternative product, which be used in some food products.

Aim:

- **To prepare jackfruit seed flour based chocolate and to standardise and evaluate the sensory qualities of different treatment.**

Exercise :

- **Prepare jack fruit seed flour chocolate with various % with different % of cocoa butter and different 4 variations with 20% powdered sugar(T_1), 25% powdered sugar for (T_2 and T_3)**
- **Prepare 3 treatments with 6% cocoa powder**
- **Prepare 3 treatments with 3 % additives**
- **Prepare 3 treatments with 1 % salt.**
- **Sensory evaluation using 9 point Hedonic scale.**

TREATMENTS

T_1- 25% JSF +45% CB + 30% Other ingredients

T_2-25% JSF + 40% CB + 35% other ingredients

T_3 -30% JSF + 35% CB + 35% other ingredients.

JSF- Jackfruit seed flour

CB- Cocoa butter

Other ingredients:

20% powdered sugar (25 % powdered sugar for T_2 and T_3)

6% Cocoa powder

3% food additives

1% salt.

Procedure:

- Mix all the ingredients and blend it to get proper consistency.
- The cook or boil it for five or seven minutes.

- Then mould it using different shape of mould.
- Then cool it and serve.

Result and Discussion:

Score Card for the organoleptic evaluation of Jackfruit seed flour chocolate

Name: Date:

Food product:

Sl No	Parameters	Variations			
		1	2	3	4
1	Appearance				
2	Colour				
3	Flavour				
4	Texture				
5	Taste				
6	Overall acceptability				

Signature:

9 point hedonic scale

Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like or dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Signature:

- Explain in detail about each treatment with different variations
- Sensory evaluation by hedonic scale – explain different attributes –
- Is T [illegible] has bitter taste with poor texture and has it melted when kept at room temperature? Explain.

- Has T_2. tasted differently? If so explain all its attributes.
  - What happened to its consistency T_1,T_2. T_3 at room temperature for long time.
    - Which has better taste? Is it T_3 ? has better taste.
      - Which had good acceptability?
- Overall, T_2 has got good acceptability compared to T_1 and T_3- attribute reasons.

Inference:

Attribute scientific aspects of jack fruit seed chocolate with different treatments and variations with supportive studies.

Exercise 11

Sensory Evaluation of Food

Introduction:

- Quality is the ultimate criterion of the desirability of any food product.
- Food quality can be evaluated by sensory and objective method.
- Standard rating scales of hardness, brittleness, chewiness, gumminess, viscosity, and adhesiveness were established for qualtitative evaluation of food texture.
- The scales cover the entire intensity range found in food products and may be expanded at any desired point for greater precision in a narrower range.
- Each point on the scale is represented by a food product selected on the basis of availability, familiarity, constancy of textural characteristics, and other criteria.
- Using the developed scales, correlation was good between sensory and instrumental (texturometer and viscosimeter) evaluations of texture.

Special Features:

- Sensory Characteristics of Food- Appearence,Colour,Flavour,Odour,Taste,Taste interactions, Mouth feels,Temperature,Texture,Brittleness,Tenderness,Astringency, Consistency.
- Conducting Sensory Tests
- Trained Panel
- Testing Laboratory
- Preparation of sample
- Techniques of smelling and tasting
- Testing time
- Design of experiment
- Reasons for testing food quality
- Evaluation Card

Sensory evaluation:

When the quality of a good product is assessed by means of human sensory organs, the evaluation is said to be sensory or subjective or organoleptic.

A scientific discipline used to evoke, measure analysis and to interpret reactions to those characteristics of good and materials as they are perceived by the series of sight, taste, odour touch and hearing, sensory characteristics of good are appearance, colour, flavour, odour, taste and mouth feel. In addition to colour, odour, taste and mouth feel certain psychological factors contribute to acceptability of foods.

Sensory test:

Sensory tests are well integrated with the overall plan of development of the product. The reason for testing good quality is to know the consumer reference, effect of variation in processing on quality, to detect the presence of off-quality. The requirement to conduct sensory evaluation by trained panel members, testing laboratory and prepared samples. The samples should be prepared properly and different satisfied methods are used for analysis.

Different sensory tests are employed for good evaluation. The tests are grouped into four types.

A. Difference tests.
B. Rating tests
C. Sensitivity tests
D. Descriptive tests.

The selection of a particular test method will depend on the defined objective of the test, accuracy and personal available for conducting the evaluation.

We conducted different tests with 5g of sugar in 50 ml of water as sample and eg. Add Sugar in 50 ml water as sample. Evaluate the sensory characteristics of the sweetness.

The tests were conducted by four panel judges.

A. **Difference tests**:
   1. Paired comparison test: The panel members receive several pairs of samples; these may be different over the same samples in each pair. Samples are always given in code numbers.
   2. Different samples are given in each pair which differs in the intensity of one characteristic, eg. Sweeteners, bitterness or rancidity. In each pair the samples with more or less intense taste will have to be picked out.

Paired comparison test

Name:

Product

You are given one or several pairs of samples. Evaluate the two samples in the pair for sweetness. Is there any difference between the two samples in the pair.

Code No. of pairs	Yes	No
Do	-	x
Do	X	-

signature

Duo-Trio test:

This test employs three samples, two identical and one different. The panel is first given one of the pair of identical samples as known reference sample and then the other two successively in random order and asked to match one of these with the first. A positive answer is required, even if it to a guess. The chances of probability of placing the samples in a certain orders are one half.

Duo-Trio test:

Name:

Product:

The first sample 'R' given is the references sample test carefully.

From the pair of coded sample next given, judge which sample the same as 'R'

Set No	Code No. of pair	Same as 'R'
1	AA	x
II	B	--
III	A	x

Triangle test:

This test employs three samples, two potential and one different, presented simultaneously to the panel. The judge is asked to determine which of three to the odd sample to a positive answer to required even if it to guess. Since all three samples are unknown, the chance of probability of reaching the sample in a certain order is one-third. Two samples A and B can be presented in two combinations AA.

Triangle Test

Name:

Product:

Two of the three samples are identical. Determine the odd sample.

Set	Code No. of samples	Code No.pf odd sample	Comment on add sample
I	BBA	A	More sweet
II	ABA	B	Less sweet
III	AAB	B	Less sweet

Result and discussion:

In paired comparison test, the first pair of samples 'AA' was identical and there is no difference between the samples. As the second pair, 'AB' the difference was found because 'B' was less sweetening than 'A'.

As duo-Trio test, the judges picked up the samples which are perfectly matching to the reference sample.

As triangle test, the judges picked up the odd samples 'A' from BBA, B from ABA and b from AAB.

Inference:

Attribute on important scientific aspects of Sensory evaluation with supportive studies.