An Exploratory study on leavening agents - In excellence of food products and as a foundation ingredients

Prof.Ramen Chowdhury,
Department of Hospitality & Tourism,
NSHM School of hotel management, Durgapur, West Bengal, India.

Abstract: - In food industry we have many kind raising/leavening agents accessible to chef. These include Activated dry yeast, compressed yeast, baking soda or sodium bicarbonate, ammonium bicarbonate, potassium bicarbonate, baking powder, baking soda, calcium phosphate and sodium aluminum sulfate and leavening acids. Producing carbon di oxide (CO2) and defusing sodium bicarbonate is the primary role of leavening acids, but also significant to secondary role and effects of raising agents. Taking into thought these evidences, the objectives of paper is to establish the connection between magnitude and excellence of leavening agents and the quality of bakery products.

Keywords: - leavening agents, yeast, baking powder, foundation ingredient,

The purpose of raising agents is to “puff-up” the foodstuff, so that it spread and increases. There are five type of raising agents. Leavening agents aerate and contribute porosity and lightness to products thus enhancing their palatability. Leavening depends on the development of a steamy substance when the leavening is subjected to warmth. Air, steam, and CO2 are gaseous leavening mediators. In some products all three agents contribute in varying degrees to the leavening process; in others just one or two leavening agents are involved.

Air and water are incorporated into flour blends during their preparation, while CO2 is made within the foodstuffs by chemical or biological action of the constituents. A light, porous texture, a source of gas, a mix that's pliable and capable of entrapping gas bubbles as they expand, and a physical framework that becomes rigid upon baking. The lightness and porosity achieved are dependent upon the sort of leavener present, the gas- holding capacity of the flour mixture, and therefore the baking conditions.

Some air is incorporated as ingredients are manipulated and combined. Air is thought to be an essential leaven in baked products. When the bubbles of air are exhausted from a batter, the effectiveness of other leavening agents is reduced. A pound cake utilizes both air and steam for leavening, but when the air is removed, the leavening action of steam is reduced severely, yielding a very heavy product.

Generally, specific techniques are used to incorporate all possible air during the preparation of products. Air is retained when whole eggs, egg whites or yolks are beaten to produce foam. Egg whites incorporate and retain air the most effectively; beaten whole egg and yolks retain considerably less air, producing foams of a lesser volume than egg white alone. Egg whites beaten to optimum stiffness retain air, but beating to the stage of dryness causes loss of air. Over beaten egg white foam is no longer elastic and releases air as it is manipulated. Egg foam must be folded into batters carefully to reduce loss of air.

Significant quantities of air can be introduced when solid fats are creamed. Shortened cakes rely on air for a portion of their leavening. Most hydrogenated shortenings, which often are used in shortened cakes, contain about twelve percent air. In addition, useful amounts of air can be incorporated into a thoroughly creamed fat, sugar, and egg mixture. The sugar crystals promote the incorporated during creaming. A thorough creaming of fat and sugar produces many tiny air bubbles and a gas in a solid foam, which is crucial for fine textured cakes. The air cells incorporated into the fat establish the textural character, which will be reflected in the baked shortened cake. The air cells act as nuclei into which both carbon dioxide and steam migrate during mixing and baking.

Mixing and beating are other techniques for incorporation of air into flour mixtures. Continuous whipping can incorporate some air into stiff batters or dough. In some cases, however, mixing beyond the optimum can lead to loss of air. Batters at room temperature incorporate and retain air more effectively than extremely cold or warm batters. Warm batters are extremely fluid and readily release trapped air. Viscous batters effectively trap and retains air, while thin batters are less able to do so.
Products baked very soon after preparation receive maximum benefit from air leavening. Air contributes somewhat to the total increase in volume during baking because the increasing temperature expands the air in the cells and creates pressure, which stretches the cell walls. This effect is especially apparent in angel and sponge cakes.

All batters and dough include liquid in either small or large amounts, or some of this liquid is changed to steam for leavening action during baking. When water is converted to steam, it is capable of expanding to 1,600 to 1,800 times the original volume, making it an effective leavener. The dramatic leavening capacity of steam is observed in the baking of cream puffs and popovers. Both of these products are leavened primarily by steam. They have a high ratio of liquid to flour. Products utilizing steam as the primary leavening agent require a hot oven to transform water very quickly to steam. The steam presses against the cell walls in the baking batter or dough and stretches the cells until the protein denatures and loses its extensibility. The amount and distribution of steam pockets influence the size and number of pores in the crumb of baked products. In sufficient steam promotes a low volume and coarse texture in baked products.

Steam contributes some leavening action to all baked products, but other leavening agents also are needed to achieve the desired volume and texture when products with lower percentage of water are prepared. The water available conversion to steam may be the added liquid or other ingredient with a high water content, such as eggs.

The amount of steam available for leavening is determined by the ratio of water to flour. When the ratio of water to flour is relatively small, as in puff pastry, sufficient steam is produced to aid in separating layers of pastry to achieve flakiness but not to form a hollow shell. The water content of egg generates enough steam to contribute significant leavening to sponge and angel cakes. However, some of the water in flour products is also bound into starch granules when the starch in the flour gelatinizes during baking. Also, not all of the steam produced in flour products is utilized for leavening; some of it lost through evaporation.

This may be introduced through chemical and biological agents. Carbon dioxide is formed by the action of acid on baking soda and the action yeast on sugar. Chemical leaveners produce carbon dioxide more quickly than yeast. The chemical leavens baking powder or soda an acid – furnish carbon dioxide in many different baked products. The biological leavens – yeast

or some bacteria – produce carbon dioxide to leaven bread products.

The reaction of soda also called sodium bicarbonate ($NaHCO_3$) and acid results in the production of carbon dioxide and a salt. In following reaction HX represents any acid.

$$NaHCO_3 + HX \rightarrow CO_2 + Na\,X + H_2O$$

Soda — Acid — Carbon Dioxide — Salt — Water

Since this reaction is rapid and complete at room temperature, products leavened with acid (vinegar, sour milk) and baking soda must be baked immediately to avoid loss of carbon dioxide.

Buttermilk and sour milk contain lactic and are common acid ingredients to use with baking soda. Sweet milk can be made sour by removing one tablespoon of the milk in one cup and replacing it with one tablespoon of vinegar as lemon juice. One cup of either of these milks generally contains sufficient acid to react completely with one-half teaspoon of baking soda, thus producing adequate carbon dioxide for leavening about two cups of flour.

The degree of sourness in sour milk can vary. Milk that has just become sour is less acidic than very sour milk; however, the general rule of one-half teaspoon of soda to one cup of milk is still applied. When the milk is only slightly sour all of the soda may not be neutralized, and a somewhat bitter flour (due to excess soda) may be noted. The excess soda may cause a yellow colour in the product, a course texture, and increased browning of the crust. The anthoxanthin pigment of flour turns yellow in as alkaline medium. Fruit juices, brown sugar, honey, molasses and corn syrup contain variable amounts of organic acids such as citric or acetic. Generally, one-fourth teaspoon baking soda is a used with one-fourth to one-half cup molasses or with one-half cup sour or buttermilk. Carbon dioxide is produced as soon as acid and soda are combined in a moist medium during the mixing process. The salts produced by the reaction of soda vary with the acid. For e.g., with acetic acid the salt is sodium acetate, with citric acid the salt is sodium citrate, and with lactic acid the salt is sodium lactate. These salts do not contribute unpleasant flavours.

Baking powder containing soda, cream of tartar and potato starch was produced in 1858 by Dr. William Price of Illinois. The formula today remains the same-soda, an acid and starch. Federal regulations require all baking powders to yield a minimum of 12 percent carbon dioxide. Most baking powder provided 14 percent or more to compensate for loss during storage. Cornstarch and calcium carbonate separate the acid ingredient and soda so they do not react. The cornstarch and calcium carbonate are inert and act as a filler or standardizing agent so that a given measure of all types of baking powders produce the same amount of carbon dioxide. A small quantity (0.15 percent) of an optional ingredient, powdered dried egg albumen, may be added to increase viscosity of the batter, thus helping to retain leavening gases. Sodium bicarbonate (soda) is the alkaline ingredient used in all baking powders; the percent of soda incorporated in a baking powder formula varies with the acid salt(s) used. Dry salts available for use in baking powder include tartrate, phosphate, sodium aluminium sulfate, sodium acid pyrophosphate, and sodium aluminium phosphate. Both phosphate and tartrate salts are classed as quick or single-acting because they liberate carbon dioxide quickly when they react with soda in the presence of cold liquid. The potassium salt of tartaric acid is cream of tartar and can be combined with soda to produce a homemade baking powder. Each teaspoon of soda and one-half teaspoon of cream, tartar. The reaction with tartrate is as follows:

$NaHCO_3$ + $KHC_4H_4O_6$ → $KNaC_4H_4O_6$ + $2CO_2$ + H_20

Sodium Bi Carbonate — Potassium Acid Tartrate — Sodium Potassium Tartrate — Carbon Dioxide — Water

Dry acid salts available to commercial bakers range from those with very slow to rapid reaction rates. Some of these acid salts release 8-10 percent carbon dioxide before baking and the remainder during baking phosphate salts react at room temperature but more slowly than tartrate. Calcium acid phosphate (also called mono calcium phosphate) and sodium acid pyrophosphate are the commonly used phosphate salts. Sodium aluminium phosphate has a slow reaction rate and thus retains release of carbon dioxide for the baking period.

A leavening derived from glucose available for commercial use is gluconodelta-lactone, a lactone of gulconic acid. Quick breads leavened with gluconodelta-lactone and soda have the appearance and texture, but not the flavour of yeast bread.

Leavening acids used alone or in combination in packaged mixes include sodium acid phyrophosphate, anahydrous monocalcium phosphate, and sodium aluminium phosphate. Because sodium aluminium phosphate accelerates development of rancidity in fats, it is not used in dry mixes containing fat. Instead, combinations of phosphates baking powders are used. Although a variety of baking powders are available to commercial bakers, only the double acting baking powder (some carbon dioxide liberated during mixing and the remainder during baking) is available to home bakers. Double-action baking powder contains sodium aluminium sulfate (SAS) and monocalcium phosphate monohydrate. Carbon dioxide is produced through a series of reaction. Monocalcium phosphate monohydrate and soda react to release carbon dioxide as soon as dry ingredient are moistened. The next reaction involves sodium aluminium sulfate, which liberates sulfuric acid when it is heated with moisture.

$Na_2Al_2(SO_4)_4 + 6H_2O \xrightarrow{Heat} 2Al(OH) + Na_2SO_4 + 3H_2SO_4$

Sodium Aluminium Sulfate — Aluminium Hydroxide — Sodium Sulfate — Sulfuric Acid

The sulfuric acid then reacts with additional soda during baking.

$3H_2SO_4 + 6NaHCO3 \rightarrow 3Na_2SO_4 + 6CO_2 + 6H_2O$

Sulfuric Acid — Sodium Bicarbonate — Sodium Sulfate — Carbon Dioxide — Water

Double action baking powder is formulated to release carbon dioxide quickly during the mixing process at room temperature and to release additional carbon dioxide during baking. The residue remaining after the release of carbon dioxide tends to have a bitter flavour. (Source: IHM)

Baking powder are the leavening ingredient in a variety of baked products: biscuits, cakes, coffeecakes, cookies, and muffins, nut breads, pancakes, shortened cakes and waffles. Ingredients, proportions of ingredients, mixing methods and baking temperatures vary among the varieties of baked products. All of these variations influence optional levels of leavening

ingredients. Too much baking powder yields products with a coarse texture and one, which may over expand and collapse during baking. Products with too little baking powder are low in volume and compact. The usual proportions of baking powder are one to two teaspoons per cup of flour for shortened cakes, one and one-fourth to two teaspoons per cup of flour for quick breads.

The leavening ingredients also influence the pH of the batter. Salts resulting from Sodium Aluminium Sulphate baking powder are less acidic than from tartrate or phosphate powders. The flavonoid pigment of flour become yellowed in an alkaline pH and white in and acidic pH.

One teaspoon of baking powder donates as much carbon dioxide as only one-fourth teaspoon baking soda. Soda, however, requires the addition of acid to release carbon dioxide. Consequently the complete replacement of baking powder with soda must also contain an acid such as sour milk or fruit juice or pulp. Although the acidity of these products differs, a useful solution is to use one-fourth teaspoon of soda for one-half cup of acid (buttermilk, sour milk, or fruit juice or pulp). An excess of soda yields quick bread products with an unpleasant flavour and yellow spots on the surface.

Leavened breads making are an antique art cultivated unique by the Egyptians and then followed by the Greeks and Romans. They apparently allowed yeast organisms from the air together in a mixture of liquid, flour and /or sugar. These mixtures were used in bread doughs. The liquid mixture or a small portion of the dough, known as a starter, could be saved from one baking to the next. These starters contained wild yeast and often bacteria. Those organisms which often promote sour fermentations influence the flavour and other characteristics of the bread.

Wild yeast is readily available from the air, but some give bread an undesirable flavour. The yeast sold commercially is carefully selected for its bread making qualities and is identified as saccharomyces cerevisiae. Yeast may be purchased as active dry yeast or as a compressed cake. Compressed yeast has higher moisture content than the active dry and must be refrigerated. Yeast is a unicellular plant. It is cultured in dilute molasses, recovered by filtration, and compressed into a cake. This cake is extruded and dehydrated to about 8 percent moisture and then ground to form active dry yeast. It is packaged in vacuum-sealed, foil-lined envelope containing about one-fourth ounce or seven grams of granular dried yeast. It keeps without refrigeration for a relatively long time. Compressed yeast contains about 72 percent moisture, in sold in cornstarch containing cakes weighing about one-half ounce. A fresh cake is creamy gray in colour, somewhat fragile, and breaks sharply. Compressed yeast is good as long as it crumbles easily even though it may appear slightly brown in colour.

Yeast can change most of the sugars (except lactose) originate in batters and dough's to carbon dioxide and alcohol. The fermentation of sugar by yeast generally involves a complex anaerobic process involving a series of reactions, without oxygen. Most of the enzymes involved in the fermentative process are contributed by yeasts, and some enzymes present in flour are also involved. The reactions in the fermentation process can be summarized as follows.

$C_6H_{12}0_6 \rightarrow 2C_2H_5OH + 2CO_2$

Glucose Ethanol Carbon dioxide (ethyl alcohol)

A small amount of sugar is usually added to yeast-flour mixture to speed the production of carbon dioxide. When sugar is not added, for

instance, in French bread, yeast slowly produces carbon dioxide from the small amount of sugar present in the flour and from the maltose produced by the amylase enzyme in flour. The use of yeast as a leaven is since ancient times. Compressed yeast is dissolved in lukewarm water for use in dough. Active dry yeast is re-hydrated at temperatures between 100°F and 150°F (40°C - 45°C) to avoid in activating the yeast. Active dry yeast may also be added directly to abut one third of the flour and other dry ingredients and blended before adding to all of the liquid, which has been warmed.

Any types of Yeast is sensitive to high temperature. Temperature of about 27°C - 29°C are considered perfect for proofing dough. A high temperature may cause the dough to rise quicker, but may also encourage growth of unwanted microorganisms. Lower temperatures require long time a proofing period. At refrigerator and freezer temperatures, yeast increase is slowed or dormant. Proofing is also retarded above 35°C and the yeast is destroyed at abut 54°C. A hot oven, as well as hot liquid, destroys yeast.

Some bacteria also yield carbon dioxide as in sourdough and salt rising breads. Sourdough bread is leavened with bacteria in salt rising bread. The bacteria produce acetic and lactic acids, which give the sourness. The characteristics flavor of these doughs is dependent upon conditions and the ingredients used to prepare the starter. Hygiene is essential, the starter must be covered with a cloth so that air is accessible and impurities are minimized while the fermentative microorganisms are cultured. The starter and the raw dough containing the starter should not be eaten or tasted. If bad colour or odour grows, the starter, the dough, or the foodstuff should be discarded. Commercial starters contain pure strains of bacteria and should be used rather than cultures developed from the ingredients or from the air. (source :-IHM, Chapter 21 leavening agents)

The function of raising agents is to "puff-up" the food, so that it spread and raises. There are five type of raising agents.

(1)Chemical Raising Agents :- baking powder of various type, when moistened with water and heated , evolve CO2 gas which expands during baking and imparts volume to cakes.

Ex. Baking powder.
- Baking soda.
- Sodium-bi-carbonate.
- Cream of tarter.
- Ammonium Carbonate.

Used in :-Muffin, Cherry bun, Sponge cake.

Use as :-Break fast.

"Aeration agents"

Ammonium bicarbonate
- Soda or bicarbonate of soda
- Potash or potassium carbonic acid
- Baking powder

(2)Biological raising agents.

Ex. yeast.
- Activated dry yeast
- Dry yeast
- Compressed yeast.

Used in:-sandwich bread, Bread roll, masala bread, French bread, Brown bread.
- Use as :-break fast and snacks items.

(3)Mechanical raising agents.

When fat is whipped with sugar or flour, the mixture is filled with air cells which expand under the action of heat giving volume to the product.
- To incorporate co2 gas and steam.
- Whisking. Beating.
- Use in:-To making sponge cake for Swiss roll.
- Use as :-Desserts item.

(4)Lamination
- Folding, Rolling.
- Use in:- patties, puff paste. Flaky paste.
- Use as:- snacks item.

(5)Combination of two
- Folding and lamination + biological. Yeast. (biological + lamination)
- Used in: - Danish pastry.
- Use as:-breakfast items.
- Air is incorporate by sifting flour, by creaming shorting by beating eggs or by beating the mixture itself.
- Water vapor is formed in quantities sufficient to raise the mixture when liquid and flour are in equal volumes.

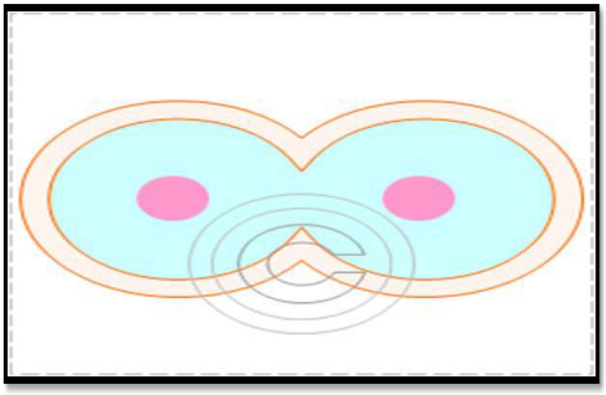
Yeast has been used in bread making since its accidental discovery more than 4,000 years ago. Yeast is a unicellular micro-organism of plant origin. Biological_name is "saccharomyces cervisiae'. Under right condition yeast increase by division and it is this process which makes yeast useful for baking. It needs air, moisture, warmth and nourishment (food-in form of sugar) to multiply and produce carbon-di-oxide to raise dough. Yeast is available both in fresh as well as dried form. Yeast consists of microscopic , unicellular ,plants forms which requires three condition to produce co2 for the purpose of raising food, the condition are:-

(1)Temperature (27C)

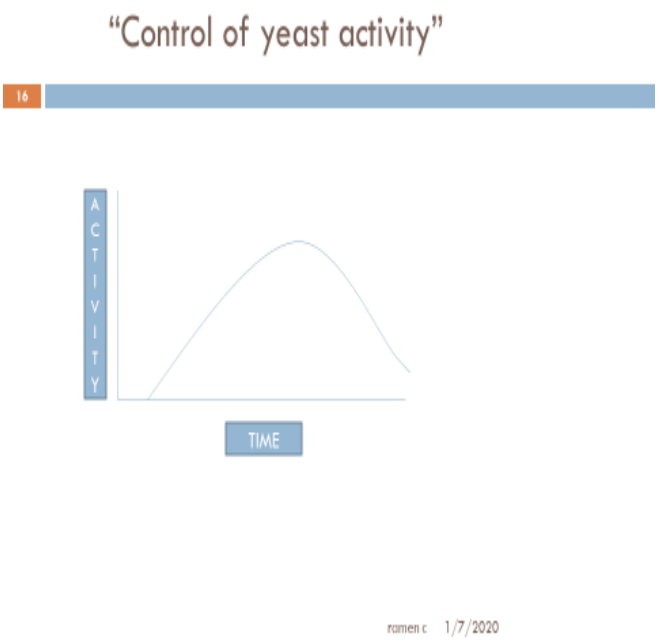
(2)Moisture (Water, Milk)

(3)Food (Sugar or Glucose) C6 H12 O6

Yeast multiplies by budding, when placed in a liquid medium at temperature of 80-85 F containing simple sugar. Then the cells would start growing buds on its cell wall which keeps on growing until the daughter cell acquire the same size as mother cell. Then the buds separate from the mother cell and producing other buds.



Yeast produce an enzyme called zymase which reacts with glucose to produce co2 and ethyl alcohol in the presence of the above 3 condition. Yeast is available in three forms.
(A)DRIED YEAST. (B)ACTIVATED DRIED YEAST. (C)COMPRESSED YEAST.



DRIED YEAST:- This is a mixture of yeast with corn flour or cornmeal pressed into cakes and dried .This yeast continues to live but an inactive stage. When furnished with warmth, food and moisture, it begins to develop and multiply, but this process is slow. Dried yeast has to be soaked in lukewarm water and mixed with very soft dough.

ACTIVATED DRIED YEAST:-_This develops more rapidly than dried yeast and the type now available. It can be used in straight dough mixing. It is perishable than compressed yeast. The shelf of both dried yeast and A.D. yeast is longer at refrigerated temperature than at room temp. The advantage of A.D. yeast is that under normal conditions, it has a self-life of one year. A,D yeast should be stored in cool and dry place . Manufacturers state that ¼ ounce of dry yeast equals 3/5 ounce of compressed yeast. (1 ounce=28 gm)

COMPRESSED YEAST/Fresh Yeast:- Compressed yeast is a moist mixture of yeast plants and starch .It remains active and will grow multiply rapidly, when added to dough. It should be kept at refrigerated temperature and keep well for several month. liquid yeast are used in house hold bread baking.

Average analysis of yeast is as following:-

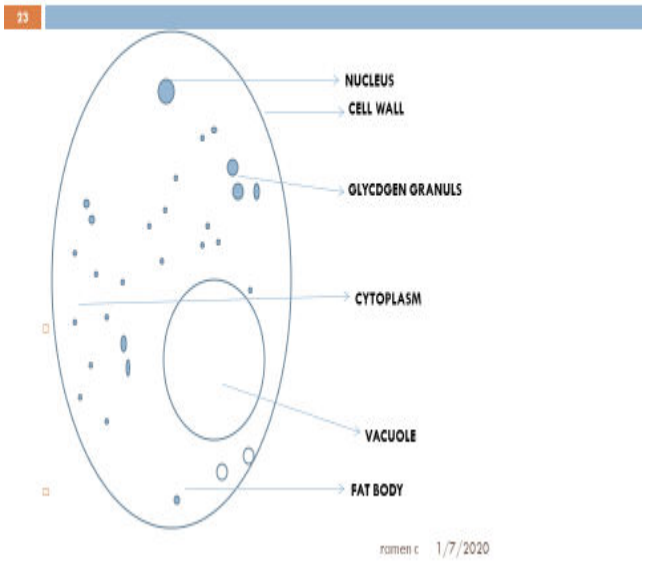
Proteins	14%
Carbohydrates	10%
Fat	0.5%
Mineral matter	2.5%
Moisture	73%
Enzyme	0.5%
Vitamins	0.5%

Temperature for yeast development in bread dough.

- 2C:- yeast is inactive at this stage.
- 16C-21C:- yeast acts very slowly at this stage.
- 21C-32C:- best temperature for yeast to in bread dough.
- 59C:- yeast dies at this temperature.

COMPRESSED YEAST	ACTIVATED DRY YEAST
1. It is pale gray in color, crumbly in texture and has a pleasant , fruity smell. 2. Should be stored in a refrigerator loosely wrapped, can be kept for a couple of weeks But it can be frozen for few months. 3.Gives best products. 4.Compressed yeast should not be kept in normal temperature or room temperature.	1. Available in granule form,(like poppy seeds) Color is little darker than compressed yeast . 2. It can be store in normal temp. 3. Products is not so good. 4. In normal or room temp. it can be stored for one year, that is the reason cruse, shipping industry are using .

'Yeast cell'



WHEN USING YEAST THESE POINTS SHOULD BE REMEMBERED…

1. Yeast remains inactive in cold, It react in warmth.
2. It is killed by heat, if temperature is over 127 F.
3. Sugar feeds the yeast and in the dough it caramelizes on the outside, forming a brown crust.
4. The starch in the flour provides food for the yeast, the starch gelatinizes due to the presence of moisture in the dough.
5. If salt is added in the correct proportion it gives a good flavor, controls fermentation and improves the color of the finished goods.
6. The yeast should be removed from the refrigerator and used at room Temperature (27C).
7. Salt retards working of yeast, the more salt used the slower action of yeast.
8. Best temperature for yeast action is 21-27 c(40-51 F).
9. Yeast dough must be kneaded to make an elastic dough and to distribute the yeast evenly. Elastic dough is requires to allow the gases to expand.
10. Proving means that the dough is allow to double its size. This should occur in a warm place at 27c or above.

Storage of Yeast:-

1.Wrap the yeast and store in a cool place .
2.Order only when its required.
3.It must be perfectly fresh and moist, free from any fungus etc.
4.Yeast should crumble easily.
5.It is pale gray in color .
6.It should have a pleasant smell.

USE:- Yeast is used in Bread dough, roll ,bun ,white bread , brown bread , whole meal bread , French loaf, doughnut ,Baba-au-rum, Danish pastry.

HOW TO USE YEAST:-

- ☐ Before using yeast put in the lukewarm water, after five minutes it will melt and then you can use it. If you use hot water, the dough will spoil.
- ☐ Put the water in your palm if you can tolerate the temperature that means that water is lukewarm.

Conversion of centigrade to Fahrenheit	
If Centigrade is 120 then Fahrenheit would	If Fahrenheit is 250 then centigrade would

be.. Formula C/5= F-32/9 Or 5(F-32)= 9C Or 5F-160= 9C Or 5F= 9C+160 Or F= 9C+160/5 Or F= 9 x 120+160/5 Or F= 1080 + 160/5 Or F= 1240/5 Or F= 248 Ans.	be.. Formula C/5= F-32/9 OR C/5 =250-32/9 OR C =(250-32)5/9 OR C = 218x5/9 OR C =1090/9 OR C =121 Ans.