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II M.Sc., SEMESTER III

MBE – IV-FOOD TECHNOLOGY

UNIT - I:

Food preservation: Principles and methods – Perishable, semi-perishable and non-perishable foods – Methods of preservation – Temporary preservation – Asepsis, low temperature, pasteurization – Permanent preservation – Sterilization processing by heat, effect of acidification.

UNIT – II:

Preservation by salting, Preservation by sugar syrup – Preservation by concentration – Preparation of jam jelly – Pole of pectin in jam – Preservation by chemicals: Benzoic acid, parabenzene, sulphur-di-oxide, sulphites nitrites, diehylpyrocarbonates (DEPC), hydrogen per oxide, chlorine and CO_2.

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Source:

1. Manorajan Kalia and Sangita Sood,1992, Food Preservation and Processing. Department of Food Science and Nutrition, College of Home Science, Himachal Pradesh Agricultural University, Palampur.

UNIT-I

Food Preservation—Principles and Methods

Foods have been preserved for centuries by various techniques. Food preservation can be defined as the science which deals with the process of prevention of decay or spoilage of food, thus allowing it to be stored in a fit condition for future use. Various methods for the preservation of foods based on techniques which eliminate moisture and other factors causing food spoilage, have been devised and practised.

For purpose of food preservation, foods are classified as perishable, semi-prishable and non-perishable.

1. Perishable Foods

The perishable foods are those which deteriorate quickly after harvesting such as tomatoes, mangoes, papaya, peaches, plums and other juicy fruits, also some juicy vegetables like cucumber, snake gourd, bitter gourd etc., also meat, fish and poultry. These foodstuffs have a high degree of moisture content and are highly susceptible to spoilage.

2. Semi-Perishable Foods

They have much less moisture content *e.g.* beetroots, carrots, peas, green beans, pumpkins and apple. These foods also contain certain natural inhibitors to spoilage such as roots, vegetables and eggs. They have received some type of mild preservation treatment which creats great tolerance to the environmental conditions during distribution and handling such as pasteurized milk, lightly smoked fish and pickled vegetables.

3. Non-Perishable Foods

They have very low moisture content. They are mature food grain cereals, pulses and nuts and are not easily susceptible to spoilage by microorganism and enzymes.

Some of these foods have been made shelf-stable by suitable means such as canning, oil or dried processed to reduce their moisture contents such as raisins.

PRINCIPLES OF FOOD PRESERVATION

1. Preservation or delay of microbiological decomposition (Preservation Techniques).

   (*a*) By keeping undesirable microorganisms from the food (asepsis).

   (*b*) By removal of microorganisms from the food, such as by *filtration*.

   (*c*) By hindering the growth and activity of microorganisms, such as by low *temperatures*, *drying*, *anaerobic conditions*, or *chemical preservatives*.

   (*d*) By killing the microorganisms present in the food, such as by *heat*, *irradiation* or *mechanical* means.

2. Prevention or delay of *self-decomposition* of the food (*chemical spoilage*).

   (*a*) By destruction of inactivation of food enzymes, such as by *blanching*.

   (*b*) By prevention or delay of purely chemical reactions, such as prevention of oxidation by an antioxidant, etc.

3. Prevention of damage to the food from insects, animals, mechanical means, etc. (packaging).

Use of combinations of these principles governs the keeping quality of the product correlated with the storage time and temperature. For example, bacteriological activity may be arrested by killing the organisms using the principles involved with irradiation. Enzymes may be in[illegible]activated by blanching. [illegible] and contaminants may be kept from the product by proper packaging. The keeping quality of this product should be quite extensive assuming a package of high integrity is used. It may not be indefinite, depending upon the time and temperature of storage and the stability of product. The product, because of chemical reactions, may tend to change over a period of time, depending upon the storage of temperature.

METHODS OF PRESERVATION

There are two types of preservation.

A. *Temporary Preservation.*

B. *Permanent Preservation.*

A. TEMPORARY PRESERVATION

Some of the most important of the food industries are based upon methods of temporary preservation. The method to be chosen will vary with the product to be held temporarily and with other factors.

1) Asepsis

Keeping out microorganism. This type of food preservation is fairly common in nature where an outer skin or protective shell keeps undesirable contaminates from the food *e.g.* the shell of eggs, skin on fruits such as apples etc. These products remains in a bacteriological inactive state until contaminates penetrate the shell or protective covering.

The inception of spoiling of a food product depends largely upon the number of microorganisms present. In the handling of fruit for the manufacture of various fruit products care in picking, placing in boxes, and transportation will greatly increase the keeping qualities of the fruit and will usually result in a finished product of superior quality. Dirty lug boxes and rough handling infect and bruise the fruit so that microorganisms are greatly increased in numbers and conditions are made favourable for their growth.

Washing dirty fruit and vegetable before they are used in the manufacture of certain products is often advisable and reduces the number of microorganisms.

Certified milk is made under conditions that tend to exclude most microorganisms from the milk. Its production is a good examples of industrial asepsis.

The principle of asepsis is carried to a much higher degree in the manufacture of serums, vaccines, and antitoxins. In these cases the absolute exclusion of microorganisms is sometimes accomplished. This is also true in the preservation of fruit juices by germ proof filtration.

2) Low Temperatures

Microorganisms are not killed by low temperatures, but their multiplication and activities are inhibited. Low temperatures also retard chemical changes.

Enormous quantities of eggs, meat, fruits and vegetables are held in cold storage, so that they may be made available for a large proportion of the year. In all cases the principle involved is the same *viz.* the temporary inhibition, by low temperatures, of microbiological and chemical action responsible for decomposition.

5. Pasteurization

When a product is subjected to a temperature that kills a great many, but not all, of the organisms present, the process is spoken of "Pasteurization".

The heating not only kills many organism but also greatly weakens and delays the development of those not killed which is an important factor in the keeping of pasteurized products. The term 'pasteurization' is often applied to the preservation of fruit juices by heat. In this case, however, it is very probable that all organisms capable of growing in the liquid are destroyed by the heat, and hence preservation is usually permanent.

B. PERMANENT PREVENTION OF SPOILING

The permanent preservation of food may be accomplished in several ways, most of which depends upon methods of completely eliminating or preventing the activity of microorganisms capable of destroying the product. The method to be adopted will depend upon the character of the material to be preserved and upon other factors.

1. Sterilization or Processing by Heat

Sterilization by heat means the complete destruction by heat of all forms of life in the product sterilized. In order that sterilized products shall not spoil, they must be sealed in such a manner that all live microorganisms are excluded.

In commercial practice not all cans of food are sterile. Nevertheless, they usually do not spoil because conditions in the can are not favourable for the organism concerned. The pH may be too low or oxygen may be lacking therefore, the term "Processing" is preferable to the term "Sterlization" when applied to canned foods.

The temperature is necessary to sterilize different products varieties. The products that are difficult to sterilize are low in acid and often high in protein and contain spore-bearing bacteria. The acidity of fruits, tomatoes and juices greatly lowers the death or sterilizing temperature of the organisms occurring on these products, which explain why acid fruits are easily sterilized, even if spore-bearing organisms are present.

3. Effect of Acidification

The vegetables and meats acidified with lemon juice or vinegar are easily sterilized. This principle is made use of in the so-called "lemon-juice" method. In this method a small amount of lemon juice, vinegar, citricacid or other harmless acid is added to the brine in which the vegetables are canned, so that after sterilization the pH will be below 4.5.

UNIT-II

7. Preservation by Salting

Salt was used in preservation of food, either alone or in combination with drying even before recorded history. In ancient Greece, salted fish formed a cheap article of diet for workers and slaves. Pickling and smoking of foods with added salt came later. Salt is important not only as a dietary supplement but also in seasoning foods to promote food intake.

The function of salting, curing and smoking has been changed with the development of newer preservation techniques, especially canning and freezing. They are now used mainly for the purpose of improving the organoleptic properties of food product. Accordingly, drastic chemical and physical treatments employed previously in these processes have been changed into milder ones, having less influence on the loss of nutritive quality.

Uses of Salt

Sodium chloride is an indispensable component of food. At lower concentrations, it contributes significantly to the flavour. At higher concentrations it exhibits an important bacteriostatic action. Salt is easily available and not expensive.

The most often-used concentrations correspond to the organoleptic requirements. Nutritional evaluation of processed foods containing salts shows indirectly, however, that the influence of low concentrations of salt is most probably not significant. While high concentrations of sodium chloride may alter many factors contributing to the nutritive value of various foods.

Applications of salt in commercial food processing may be classified on the basis of objective (flavour enhancement, preservatives, condition), on the product in which it is used, or on the basis of particular operations (quality grading, blanching etc.). The most important uses include the following :

1. As a basic flavouring ingredient with universal appeal. Salt is the major or sole ingredient of the brines in which meat and meat products, poultry products, fish and sea foods, and vegetables are canned. The composition of the brines commonly used in canning vegetables are shown in table 16 the salt content of such brines usually averages 1.5 to 2.0 per cent.

TABLE 16. *Composition of Brines Used for Canning Vegetables*

Product	*Brine, kg/100 litre Water*
Asparagus	1.75-2.25
Beans, green	1.50-2.30
Beans kidney (Raj mash)	1.00-1.50
Beans sprouts	1.50-1.75
Beets	100
Cabbage	2.25-3.00
Maize, whole kernel	1.25-1.50
Okra	0.75-1.00
Peas, green	1.75
Spinach	1.50-2.25

For centuries, salt has been known to improve the palatability and acceptability of food. The addition of salt is known to improve the flavour and acceptability of many foods, particularly meat, fish, poultry products, vegetables and even fruits. The enhancement of fruitiness in melon, watermelon, apple, pear and other products is well known. Sodium chloride reduced the sourness of acids and increased the sweetness of sugar. Organic acids, (such as malic, tartaric and lactic acids) increased the saltiness of sodium chloride, and the sweetness of sucrose but decreased that of fructose. All the sugars tested reduced the saltiness of sodium chloride. The addition of one per cent salt to sucrose solutions containing 3-10 per cent sucrose reduced sweetness, but addition of 0.5 per cent salt and 5-7 per cent sucrose solutions increased sweetness. This interrelation between sweetness and saltiness has been used for many years by housewives in seasoning food and is the basis of the commercial use of salt and sugar in preparing brines or canning vegetables like peas. Salt not only enhances sweetness, and improves natural flavours but may weaken bitterness.

2. As flavouring ingredients and preservatives in the curing of pork and other meat products, in brined herring, in smoked and dried fish and meat products and in fresh egg yolk to be frozen and used in preparation of other foods. Bacon and ham are prepared by soak in a brine containing salt, sugars and sodium nitrate. Beet is cured usually in a similar brine, chopped meats for wieners, frankfurters, etc. cured by mixing with salt and spices. Sliced bacon and sliced fish are prepared by rubbing and sprinkling salt on the flesh. Ground meats have a salt content of 2 to 4 per cent, bacon about 2.25 per cent, hams about 5 and corned meat about 6 per cent.

3. As a flavouring ingredient and curing agent in hard cheeses such as Cheddar and Swiss cheese. In cheese making, salt is mixed with the curd, not only for flavour but also to aid in whey removal, hardening and sprinkling the

curd, retarding lactic acid fermentation, inhibiting undesirable fermentations and producing desirable texture. About three kg of salt are added per 1000 litres of milk but only one third of the added salt remains in the cheese. The ripened cheese contains about one per cent of salt.

4. As a flavouring agent in butter and margarine. Although formally salt was added only as a preservative in butter making, today salt is added primarily as a flavouring agent. The salt content of butter averages about 2.0 to 2.5 per cent.

5. As a flavouring agent and for other uses in cereal products. In the baking of bread, salt is added to control and regulate fermentation by yeasts of sugars and regulate the formation of carbon dioxide. It checks the development of objectionable or 'wild' types of fermentation, has a strengthening effect on gluten and assists in the production of the desired finer grain, softer texture, and white crumb. In the presence of added salt, the water mixed with the flour and retained in the bread can be increased. The salted bread has a longer storage life. Salt is added at the rate of 2 to 2.25 kg per 100 kg of flour used. In sweet rolls, coffee, cakes, and biscuit mixes about two per cent of salt by weight of flour, and with doughnut flour one per cent by weight are used.

6. In the preparation and control of lactic acid fermentation of sauerkraut, pickles, green fermented olives and other vegetable pickles. In the production of sauerkraut and pickles by dry salting, a combination of dry salt and brine alone may be used.

7. In the brine storage of cucumbers and other vegetables, olives and other fruits for subsequent processing into canned, glass-packaged, or flexible packaging after suitable additional treatment.

8. In the brine storage of citrus peel (orange, lemon, grapefruit) and of cut melon for subsequent production of candied and glazed products.

The ability of salt to inhibit microbial growth and activity in concentrations of ten per cent and above or to exert a selective inhibitive action at lower concentrations is widely used in the production of lactic acid fermented products which may be preserved by a combination of factors, reduction in the fermentable sugar content, accumulation of lactic acid, and presence of salt. The salt used for this purpose should be low in carbonates, calcium and magnesium content and the concentration of salt should be adjusted to prevent or minimise shriveling and excessive wilting during storage in brine. In the preparation of salt stock, particular care should be taken to gradually raise the salt concentration to the desired point without interfering with the fermentation and curing process and to avoid surface growth of salt tolerant aerobic organisms (molds and yeasts).

9. For the temporary storage and handling of peeled and sliced or cut apples, potatoes etc. to inhibit enzymatic browning and discolouration during preparation for canning, freezing or dehydration. Salt, particularly when free from objectionable amounts of iron and copper impurities, has a definite antioxidant effect of its own and also has the property of enhancing the inhibition

of oxidation by other antioxidants. It improves the antioxidant action of sulphurous acid and the acid sulphities, ascorbic acid and other agents. For this reason mixtures of salt and antioxidant usually are more effective than either alone. Thus, preventing browning of a fruit like apple during freezing storage, a mixture of sodium chloride, sodium bisulphite and ascorbic acid are particularly effective. The antioxidant effect of smoke constituents on meat and fish products is also improved by salt.

Salt also inhibits the activity of oxidizing enzymes such as the polyphenol oxidase involved in oxidative discolouration of peeled, cut or otherwise mechanically injured tissues of apples, potatoes and other products. Where salt absorption from brines is not harmful and even desirable, temporary storage and handling in brines is useful in preventing discolouration during preparation.

10. In the quality of peas, beans, potatoes, and other products which can be separated into different quality grades because differences in maturity and composition are reflected in differences in specific gravity of the product. Brine quality graders of various types are used for grade separation during preparation to reduce cost of sorting by hand. Brine separation is used also in determination of the grade of the final preserved product, both canned and frozen.

11. To prevent the undesirable effects of hard water on the texture of peas and beans during blanching. Salt water blanching has been used to prevent absorption by peas and beans of calcium and magnesium from hard water and to reduce losses by leaching of soluble constituents. The addition of 2 to 4 per cent of salt to hard blanching water results in marked softening of skins of these products. Salt blanching, however, is not in widespread use because of—

(*a*) difficulties in maintaining the correct concentration of salt during continuous blanching.

(*b*) necessity to compensate for salt pick-up during blanching in preparing brine for canning, and

(*c*) accelerated corrosion of blanching equipment. Adequately controlled salt blanching is effective in preventing undesirable effects of hard water upon texture.

12. In the regeneration of zeolite or synthetic ion exchange water softener used for the preparation of soft boiler feed water and in the ion exchangers used in stabilizing wines.

13. In refrigeration, salt is used extensively with ice in cooling refrigerated railroad cans and in maintaining the required low temperatures during the rail shipment of frozen foods. Salt brines are used as secondary heat transfer media in ice manufacture and in cooling air in meat coolers and other cold storage practices.

Preservation by Sugar

Sugar aids in the preservation of products in which it is used. The high osmotic pressure of sugar creates conditions that are unfavourable for the growth and reproduction of most species of bacteria, yeasts and molds. When sugar is sufficient to draw water from microbial cells, or prevent normal diffusion of water into these cells, or a preservative condition exists. Heavy syrups will keep indefinitely without refrigeration even if exposed to microbial contamination provided not diluted above a critical concentration by moisture pick up. And this critical concentration of sugar in water to prevent microbial growth will vary depending upon the type of microorganism and the presence of other constituents, but usually 70% sucrose in solution will stop growth of all microorganisms in foods. Foods in which sugar aids preservation include syrups and confectionery products, filling in chocolate, canned fruits and juices, honey, jams, jellies marmalades, conserves, and fruits also like dates.

Sugar is pleasant to the taste, clean, uniform in quality, contains no wastes and keeps indefinitely.

SYRUPS FOR CANNING

In canning fruits, sugar in the form of syrup is used to bring out the full flavour of the fruits, care being taken not to make contents excessively sweet strength of the syrup would depend on the kind and variety of fruit. Generally the more acidic fruits require denser syrups.

Preparation

Syrup can be made either by

(1) Cold process
(2) Hot process

(1) ***In the Cold Process.*** Sugar is placed in a tank and cold water poured over it and stirred. The solution is then filtered through a muslin cloth, or fine brass wire gauze to remove insoluble impurities. Some times warm water may be added to facilitate the disolving of the sugar.

(2) ***In the Hot Process.*** Sugar and water are placed in a steam jacketed kettle, boiled and the scum removed. The syrup is clarified further. Steam helps

to sterilize the syrup and to prolong its keeping quality. The quantities of sugar and water required to prepare syrups of a given brix are given in the table.

In commercial practice, syrups of desired Brix are prepared either according to formula by which a known weight of sugar is added to a given volume of water, or by adding sufficient water to a known weight of sugar to get the desired volume of syrup. For example, addition of 23 litres of water to 23 kg of sugar will produce 36 litres of syrup of 50 degrees Brix. Similarly, to get 23 litres of syrup of 50 degrees Brix, using 13.99 kg sugar, sufficient water is added to obtain the required quantity. Generally, to avoid unnecessary weighings, a 100 kg bag of sugar is taken as the unit and a known volume of water, gallons or litre as the case may be, added to the sugar to prepare the desired syrup.

Preparatrion of Jam and Jelly

Jam

Jam is prepared by boiling the fruit pulp with a sufficient quantity of sugar to a reasonably thick consistency firm enough to hold fruit tissues in position. In its preparation about 45 parts of fruits should be mixed with 55 parts of sugar and should contain not less than 68.5 per cent soluble solids as determined by refractometer, when cold and uncorrected for insoluble solids.

Jelly

Jelly is prepared by boiling the fruits, with or without addition of water, straining the extract, and mixing the clear extract with sugar, and boiling the mixture to a stage at which it will set to a clear gel. This semi-solid food is made by not less than 45 parts by weight of fruit juice ingredient to each 55 parts by weight of sugar. And it should not contain less than 65 per cent soluble solids, flavouring and colouring agents may be added. Pectin and acid may also be added to overcome the deficiencies that occur in the fruit itself.

A perfect jelly should be transparent, well-set, but not too stiff, and should have the original flavour of the fruit. It should be of attractive colour and should keep its shape when removed from the mold. When cut, it should retain its shape and show a clean-cut surface. It should be tender enough to quiver but not flow.

JAM

Jams may be made practically of all varieties of fruits and from some vegetables. Various combinations of different varieties of fruits can often be made to advantage, pineapple being one of the best for blending purposes because of its pronounced flavour and acidity. In preparing the jam, the fruit is crushed, or otherwise finely cut, so that when cooked, the mass is fairly uniform throughout. A jam is more or less a concentrated fruit possessing a fairly thick consistency and body. It is also rich in flavour, because ripe fruit, which have developed full flavour, are used in its preparation. Pectin present in the fruit gives it a good set. High concentration of sugar facilitates preservation. A great advantage in its preparation is that it can be made completely in a single operation, unlike the preserve which has to pass through several stages over a number of days, before it is complete.

Quality Attributes in Case of Jams

Jams are of two types:

1. Type I Jam

Type I jam is prepared from a single fruit.

2. Type II jam

Type II jam is prepared from a combination of two or more fruits.

TABLE 19. *Quality Atributes of Jam*

Quality Attributes	*A Grade*	**B Grade*	*D Grade*
1. Consistency 20	17-20	14-16	0-13 or 14
2. Colour 20	17-20	14-16	0-13 or 14
3. Flavour 40	34-40	28-33	0-27 or 28
4. Freedom from defects 20	17-20	14-16	0-13 or 14
100	85	70	70

* Limiting rule applies.

A. Consistency. 1. It follows more or less the same definition as jelly except that in case of jams we don't mind the *tendency* to *flow*.

2. Extract of fruit pulp should be evenly distributed over the entire mass.

B. Colour. Colour of the jam should be bright, uniform and should have the characteristic flavour of the fruit from which jam is prepared.

C. Flavour. The flavour should be of fruit characteristic. And there should be no considerable carmalised flavour.

D. Freedom From Defects. The product should be free from seed, peel, or any other part which are not included in the product except in strawberry.

In jams we are not concerned with the gelinformation so we do not add pectin while in jelly pectin is an optional ingredient.

Preparing the Fruit for Jam-Making

The fruit is washed thoroughly to remove any adhering dust and dirt. Leaves, stalkes and other undesirable portions are removed. The fruit is then subjected to preliminary treatment which varies with the type of fruit. For example, strawberries are crushed between rollers. Raspberries are steamed, crushed and pass through sieves to remove the hard cores. Plums are heated with a small quantity of water until they become soft, and then are passed through a wide mesh sieve to separate the stones. Some times, the stones are not removed while making whole fruit plum jam. Cherries are treated in a similar way Gooseberries are whirled in a rotary vertical cylinder lined with Carborundum to rub off the tops and tails. They are then passed through sieves to separate the stalks. Pears are pooled, cored and cut into small pieces. Peaches are lye peeled, and the stones removed. They are then cut into small pieces, Apricots are cut and the stones removed, unless the jam to be made with stones is also included. Mangoes are peeled stones separated, and then sliced. The slices are passed through a pulper. Firm fruits should be boiled in a small quantity of water before sugar is added in order to facilitate pulping. Crush the fruit while boiling so that it turns into a uniform thick mass. Add sugar. Generally, cane sugar of good quality is used in the preparation of jams. The proportion in which it is added depends not only on the fruit, but also on its acidity and degree of ripeness. Sweet fruit require less sugar than tart fruits do. The quantity added should be adequate to give the maximum strength to the pectin-sugar-and gel. To ensure a minimum of 68.5 per cent sugar in the jam, generally 24.9 kg of sugars is required for every 20.4 kg. of fruit taken. The finished jam should contains 30 to 50 per cent invert sugar to avoid crystallization of cane sugar in the jam during storage. If the percentage of invert sugar is less than 30 cane sugar may crystallize out; if it is more than 50 per cent, the jam will develop into a honey like mass due to the formation of small crystals of glucose.

Allow fruit sugar mixture to stand for half an hour. So that this mixture gives sufficient water to dissolve sugar. Cook the mixture on quick fire. Crushand stir while cooking continuously to avoid burning. After addition of sugar add a little of butter if there is, excessive frothing. Continue cooking till the desired consistency is obtained or the temperature reaches 105°C.

Addition of Acid, Colour and Flavour

Acid. Generally, citric, tartaric or malic acid about 1-2 g per kg of product is added near the end point. Acids are used to supplement the acidity of the fruit for jam-making. Addition of acids to fruits, deficient in it, is a necessary because appropriate combination of pectin, sugar and acid is essential to give a 'Set' to the jam.

Colour. Only permitted edible food colours should be used, if necessary, and these should also be added towards the end of the boiling process.

Flavour. Ordinarily, jams do not require the addition of flavours, if desired, they may be added towards the end of the boiling process.

Check end point by sheet test.* Fill into clean, dry, wide mouthed bottles or jars placed on wooden boards preventing the breakage. Close the filled containers and invert the container for about 5 min. to sterilize the lid and allow them to cool.

Pour melted paraffin was on the cooled jam surface or cover the surface of the jam with a thin disc of waxed tissue paper.

**Sheet Test.* When the mass has been boiling for some time and has become sufficiently thick in consistency, dip a spoon into it and let the product run off the sides of the spoon. If on cooling the product falls in the form of a sheet instead of flowing in a single stream, it means that the end point has reached and the product is ready for filling into container. Otherwise, continue boiling till the sheet test is satisfactory.

TABLE 20. *Standard Factors for Fruits for Jelly*

Name of fruit	*Factors*
Apple	7.5
Apricot	7.0
Blackberry	10.0
Raspberry	9.0
Cherry	7.0
Crabapple	6.5
Cranberry	9.5
Fig	5.5
Gooseberry	11.0
Grape	7.0
Grapefruit	11.0
Guava	9.0
Orange	8.0
Peach	8.5
Pineapple	7.0
Plum	7.0
Pomegranate	5.5
Pear	11.0
Quince	7.5
Strawberry	12.5

JELLY

Jelly is prepared by boiling fruit with or without water, expressing and straining the juice, adding sugar and concentrating to such consistency that

gelatinization takes place on cooking. A perfect jelly is clear, sparkling, transparent and of attractive colour. When remove from the mold, it should retain its form and should quiver, not flow. It should not be syrupy, sticky or gummy and should retain the flavour. When cut it should be tender and yet so firm that a sharp edge and smooth, sparking cut surface remain.

Types of Jelly

The jelly is of two types:

Type-I Jelly. It is prepared from a single variety of fruit *e.g.* Apple, Mango, Grapes, Strawberry etc.

Type-II Jelly. It is prepared from more than one type of fruits *i.e.* 2 or 3 different fruit juice are mixed to prepare jelly. It is also known as Mixed Jelly.

Preparation of Jelly

Ideally fruits for jelly making should contain sufficient pectin and acid to yield good jelly. Such fruits as sour apple varieties which are not overmature, sour berries, citrus fruits, grapes, sour cherries and cranberries. Sweet cherries, quinces and lemons are rich in pectin but low in acid content. Strawberries and apricots contain sufficient acid but are low in pectin. Peaches, figs and pears are generally low in both acid and pectin. Because pectins are available commercially and edible acids are plentiful, it is possible to correct defects in acid content or pectin content in fruit jelly making.

Quality Attribute and Standard of Identity

Generally, quality attributes are of three types:

TABLE 21. *Quality Attributes of Jelly.*

S.No.	*Quality Attribute*	*Grade A*	*Grade B**	*Grade D*
1.	Consistency 40 points	34-40 points	28-33 points	< 28 points or (0-27)
2.	Colour 20 points	17-20 points	14-16 points	< 14 or (0-13)
3.	Flavour 40 points	34-40 points	28-33 points	< 28 (0-27)
		85	70	< 70

Individual Attributes

A. Consistency. In case of jelly consistency is related to the texture:

1. Jelly should gives a tender texture and not just like a rubber to chew.
2. It should contain a compact shape and cut with the knife, it should maintain that smooth cut shape.
3. There should be very little or no tendency of weeping called 'weeping jelly'. No drops of water on the side of jelly or no droplets at the jelly surface and this phenomenon is called *Syneresis*.

B. Colour. 1. It means clarity, transparency in case of jelly *i.e.* jelly should not be opaque rather than translucent. Colour of the product should be typical of the fruit from which it is prepared *e.g.* different varieties of grape give white product.

2. The colour should be sparkling and not dull.
3. There should not be any indication of cloud formation.

C. Flavour. 1. Flavour of the product should be typical characteristic of the fruit from which jelly is prepared. It should be free of carmalised flavour *i.e.* burning. If it is there, then the product is over cooked or cooked.

2. Good jelly should be free from any undesirable flavour.

Constituents of Jelly

Three substances are essential to the preparation of a normal fruit jelly. These are pectin, acid and sugar. Of these, pectin is the most important.

Pectin. It is possible to make a jelly of excellent consistency by combining pectin, acid, sugar and distilled water in the proper proportions. Fruit juices that are normally deficient in pectin or acid or both, will make good jelly of these constituents are added.

Acid. Acid is a necessary constituent of fruit jellies. Juices that are deficient in acidity will make good jelly if citric, tartaric or other suitable acid is added, provided the proper proportions of pectin and sugar are present.

Sugar. Sugar the third necessary constituent of fruit jellies, may be in the form of any readily soluble sugar, such as cane sugar, dextrose, levulose and maltose etc. Jelly forms when the concentration of the water-sugar-acid-pectin mixture attains a certain minimum value, which is dependent within limits on the proportion of pectin, acid and sugar.

The process of jelly making involves boiling the fruit to extract pectin (converting protopectin), to obtain maximum yields of juice and extract flavouring substances characteristic of the fruit. Water may be added to the fruit during this extraction. The amount added depends upon the juicyness of the fruit. Excessive moisture must be boiled away during concentration. Therefore, a minimum water is added compatible with good juice yields, prevention of scroching and pectin extraction. Pectin hydrolyzing enzymes are destroyed during this boiling extraction.

The boiled fruit juice is expressed from the fruit pulp by straining or pressing. The press-cake remaining may be re-extracted with water and boiled a second time to obtain maximum pectin yields. The pressed juice contains suspended solids and usually these are removed by filtration.

The acidity, pH value, pectin content and soluble solids content of the juice is determined by analysis. Deficiencies in pectin may be remedied by its addition. Generally powdered pectin is mixed with ten times its volume in dry sugar, mixed thoroughly and added to the juice. This ensures uniform distribution and controls lumping. Sugar is added to the juice either as a solid or a syrup. Care is exercised in adding the sugar to ensure its being dissolved. The juice is stirred and heated during the sugar adding stage. Boiling is one of the important steps in jelly making. The juice must be rapidly concentrated to the critical point for gel formation of the pectin-sugar-acid system. Prolonged boiling not only causes hydrolysis of pectin and volatilization of acid, but losses in flavour and colour. Vacuum concentration yields greatly improved jelly over products concentrated at atmospheric pressure. The point at which evaporation is halted is determined by the level of soluble solids in the substrate. The usual means of identification is by the use of a refractometer. Tables are available relating refractive index to soluble solids content of the sugar solutions. Jelly and preserved fruit products filled hot into containers (temperature near 87.8°C) and then sealed require no further sterilization treatment.

Ordinarily 450 g of extracted fruit juice to which is added 550 g of sugar, and heated to a temperature of 104° to 105°C at near standard pressures, will form a jelly, though it is a function of TSS in the extract.

Rhubarb, carrot juice and tomatoes may be preserved in the form jelly products, although vegetables are not generally preserved in such a form.

Fruit Jelly Calculations

Preservation by Using Chemicals

A preservative is defined as any substance which is capable of inhibiting, retarding or arresting the growth of microorganisms, of any deterioration of food due to microorganisms, or of masking the evidence of any such deterioration. It is estimated that nearly 1/5th of the world's food is lost by microbial spoilage. Chemical preservatives interfere with the cell membrance of microorganisms, their enzymes or their genetic mechanisms. Chemical preservatives are generally added after the foods are processed, Generally preservatives are divided into two types as:

(1) *Class I preservatives*

(a) Common salt
(b) Sugar
(c) Dextrose
(d) Glucose (syrup)
(e) Wood smoke
(f) Spices
(g) Vinegar or acetic acid
(h) Honey.

(2) *Class II Preservatives*

(a) Benzoic acid and sodium Benzoate
(b) Methyl and propyl p-hydroxybenzoates (parabens)
(c) Sorbates
(d) Propionate
(e) Sulphites (sulphur dioxide)
(f) Nitrites.

BENZOIC ACID

Benzoic acid and its salts are the most effective agents against yeast, and bacteria in foods which are relatively acidic in nature (2.5–4.0 pH). Used in most carbonated beverages, fruit drinks, jams, jellies and salted margarines at levels of 0.05 to 0.10 per cent.

The use of sodium benzoate in ice used for refrigeration of fresh fish has also been suggested but there appears to be no application of this kind at the present time. Sodium benzoate is used to extend the storage life of salt cod (40

SULPHUR DIOXIDE AND SULPHITES

They are generally employed in the production of wine and is the most effective inhibitor known for fruit juices and dried fruits. It allows the growth of yeast during fermentation and, at the same time, acts as a fungistat and bacteriostat. It also acts as an antioxidant and prevent discolouration of fruits by inhibiting enzymic browning. At present sulfite is permitted as a preservative in all foods which are not important source of vitamin B_1. It is also used to prevent bacterial spoilage in wine held in bulk storage. Solution of sulphur dioxide or sulfites may be used to clean holding tanks, 50 to 100 ppm may be added to the

to 45 per cent moisture). It may be used as a preservative for pickled fish in which it is added during presetting, as a powder mixed with salt, or dissolved in the cover solution with which the product is packed.

PARABENS

The paraben compounds are more soluble than benzoic acid and the sodium salts of these compounds are even more soluble. The paraben compounds are effective over a much broader microbiological spectrum, than are the benzoates and are active even in foods which are essentially neutral in pH (7.0). They are more active against molds and yeasts than bacteria. They are often used in conjunction with sodium benzoate for similar application. These compounds are used by dissolving directly in fruit juices, fruit juice concentrates, pickles, pickled beets and pickled tomatoes.

must prior to fermentation in wine making, 50 to 75 ppm may be maintained in bulk stored wine or 50 ppm in vinegar stock.

NITRITES

Nutrites are used in the curing of meats and fish, are reported to have some bacteriostatic activity but are not permitted for this purpose in other foods. There is some question as to the safety of nitrites when used as curing agents in meats.

Diethylpyrocarbonate (DEPC)

It was permitted until a few years ago in for use as a preservative in wine and in some fruit juices at a level of 0.02 per cent with the stipulation that a maximum of 5 ppm would remain after 24 hours after bottling. DEPC is effective in greatly reducing total counts of yeasts and molds in wines and fruit juices. In most products, DEPC breaks down to ethyl alcohol, carban dioxide, and water with in 48 hours Because it is used in very small concentrations up to 0.02 per cent, the amounts of alcohol and gas produced are not of any significance.

Hydrogen Peroxide

Hydrogen peroxide occurs naturally in many living tissues but is not permitted to become toxic or remain in the living tissues due to the protective action of enzymes. The breakdown products are oxygen and water. The germicidal properties of hydrogen peroxide have been widely employed.

There have been several patents which involve the use of this compound to preserve food. Concentration levels of 0.1% and lower are effective. Contrary to common belief, hydrogen peroxide is not decomposed instantly under usual conditions in acid solution when its decomposition is not catalyzed. The enzyme catalase has such ability and specific activity to decompose hydrogen peroxide.

A proposed process for sterilizing fluid whole milk involves the addition of 0.1% hydrogen peroxide to fluid milk, allowing a reaction time of several minutes for sterlization, adding sterilized catalase to decompose residual hydrogen peroxide, then heating to inactivate the enzyme. Combined with aseptic packaging, the process theoretically has potential. One objection is the damaging influence of the liberated oxygen.

Anaerobic spore forming bacteria can be killed with hydrogen peroxide. Surface sterilization of many commodities may be accomplished. In this regard hydrogen peroxide finds usage in controlling surface infections of man.

Chlorine

Chlorine is a widely used chemical disinfectant, finding an important use in the treatment of water for drinking and processing purposes. Its action is most effective at low pH values.

Carbon Dioxide

Carbon dioxide has been found to have preservative properties at higher pressures than normally encountered in the atmosphere. In addition to uses in carbonated beverages, there are applications in partially prepared foods, such as unbaked biscuits which have as their principal preservative increased atmospheres of carbon dioxide developed inpackage during storage. Storage at refrigerated temperatures permits successful distribution of such dough products for several months after preparation.

Carbon dioxide is currently being used in controlling the maturation and storage quality of fresh fruits. In this instance it is a physiological control.

Benzoic acid occurs naturally in cranberries. Cranberries are easily preserved in their native form, provided protection is given against moisture losses and respiration losses.

Benzoic acid and its salt and derivatives are a family of the widely used chemical preservatives. The use of benzoic acid in foods has been the subject of much discussion, since in sufficient concentration it is objectionable and even poisonous. Such a statement naturally can be made of almost any chemical entity. The concentration employed is a deciding factor. Sodium chloride in large quantities is poisonous to man, as is carbon dioxide. Concentration is a dependent factor. In the concentrations used by man in food preservation no untoward physiological damage has ever been found. Sodium benzoate is widely used in preserving acid foods. The benzoates generally are more effective against Yeasts and molds, than against bacteria in concentrations of 0.1% or less, the amounts allowed. Benzoic acid is more effective against Yeasts than molds, and when added to apple juice as a chemical preservative does not permanently preserve the fruit juice. If the production of the juice is such that the contamination of microorganisms is low, the action of benzoic acid is most effective, even at 0.05% levels. In combination with cold storage (0°C) benzoated cider may be maintained in acceptable condition for a month or six weeks. In highly contaminated juice, 0.1% is only slightly useful.

While sodium and amonium salts of benzoic acid are commonly used, it is the benzoic acid molecule itself that appears to be germicidal. The undissociated molecule is thought to be the active arrangement. The sodium salt is more soluble in water than the acid and the former finds preference in use.

The acidity of the substrate in which benzoates are added influence the effectiveness of the chemical preservative. In a food with a pH value of 7.0, benzoates are less effective than in an acid food, with a pH value near 3.0. In general it is felt that the germicidal activity of benzoic acid is increased ten-fold in the latter substrate over the former. In a highly acid food, the germicidal action is in the order of 100 times more effective than in slightly alkaline foods.

Germicidal ices can be prepared containing benzoic acid. The freezing point of a 0.1% solution is just slightly more than 3°C and is an euthenic mixture. If permitted, such ices may have use in food preservation and experimentally have been used in treatment of fresh fish. At 0.1% benzoic acid may improve the keeping quality of fish. The formation of trimethylamine, the odor of spoiled fish, may be supressed by this treatment without controlling bacterial populations. In this instance, the use of the chemical preservative is questionable. Benzoates are commonly used in preserving apple cider, fountain syrups, margarine, pickle, relishes and other acid foods. A combination treatment with mild heating is complementary. Benzoates in foods at concentration of 0.1% may be noticeable, and can impart a disagreeable peppery or burning taste to the food. This may be especially noticeable in treated fruit juices.