PHM 321 PROCESSING OF HORTICULTURAL CROPS (1 + 2)

Practical Manual

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FOREWORD

Horticulture continues to play a major significant role in the overall development of the country. Horticulture dealing with fruits, vegetables, flowers, its post-harvest management and allied branches is the core to Indian Agriculture and would continue to hold the belief that it is an important sector to make farmers and entrepreneurs to realize higher income and prosperity. Value addition to food products has assumed vital importance in our country due to diversity in socio-economic conditions, industrial growth, urbanization and globalization. It is not merely to satisfy producers and processors by way of higher monitory return but also with better taste and nutrition. Value is added by changing their form, colour and other such methods to increase the shelf life of perishables. Though, with the effort of Ministry of Food Processing Industry the growth of this sector is accelerated, however, there is need to discuss and sort out various related issues amongst people of various categories to increase level of value addition and improve the quality of value-added food products for domestic market as well as export. The practical manual 'Processing of Horticultural Crops' is prepared according to syllabus of 5th Dean's Committee is a very timely and relevant initiative towards improving practical skills of undergraduate students. I am confident that the practical skills acquired by the students would be helpful to them in their professional career.

I hope that the manual would be of great help not only to the students but also to all those dealing with the field/laboratory exercises in processing of horticulture. I congratulate the author/s for their making efforts in preparation of this manual.

Anupam Mishra

PREFACE

This practical manual entitled “Processing of Horticultural Crops” provides information on different aspects of processing *viz*. Instruments and equipment’s used in processing industry, physio – chemical analysis, preparation jam, jelly, RTS, squash and freezing and drying techniques. There is total thirty-four practicals in this book to impart practical knowledge to the students and will also help in their skill development. The manuscript gives an overview of processed products prepared from horticultural crops like jam, jelly RTS, marmalade, pickles, candy etc. Educational visits to commercial fruits and vegetables processing unit and plantation crop processing unit of the region may be arranged for the students for better understanding of the subject.

Author/s

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Ex. No. 1 **Date :**

EQUIPMENT & MACHINERY USED IN FOOD PROCESSING UNITS

Aim: To familiarize the students with the machineries and equipment's used in fruit and vegetable processing.

Theory: The students will visit the processing unit/pilot plant and familiarize with different machineries and equipment used in fruit processing units. The students will observe the layout and the details of the machinery for different unit operations viz; raw material receiving, washing, sorting/grading, peeling, slicing, pulping, heating, filling, exhausting, sealing, sterilization/processing, labelling and storage for different products. The list of the machineries and equipments and important chemicals used in fruit preservation is as under:

Apparatus/machineries/equipment's used in food industries

A. Basic equipment/ accessories

1. Weighing balance (1-10kg) and electronic balance (for chemical weighing)
2. Cutting Knife (SS), coring knife, pitting knife, peeling knife
3. Abrassive peeler
4. Working table
5. Buckets, Tubs, Jugs
6. Belt conveyors
7. Fruit /vegetable washer
8. Fruit /vegetable blancher
9. Bottle washer

B. Heating equipment

1. Hot plate
2. Diesel Bhatti
3. LPG bhatti/gas stove
4. Boiler

C. Juice extraction/pulping

Hand operated /motor driven

1. Fruit grater/ Fruit mill
2. Basket press
3. Hydraulic press
4. Rosing machine/burring machine
5. Screw type juice extractor

6. Pulper

D. Machineries for canning unit

1. Can Reformer
2. Flanger
3. Double seamer
4. Coding Machine
5. Retort
6. Sterilization tank
7. Lye peeling tank
8. Steam jacketed kettle
9. Exhaust box/tunnel
10. Empty can tester
11. Vacuum/pressure gauge

E. Containers

1. Glass /plastic bottles 200ml
2. Squash bottle 650ml
3. Lug cap jar/Glass jars
4. Plastic barrels
5. Beer bottles
6. PP(Pilfer proof) caps
7. Jar screw type
8. Tin Cans
9. Crown cork

F. Sealing/closing

1. Crown corking machine
2. Pilfer Proof (PP) cap sealing machine
3. Pouch sealer
4. Can cutter/ cork opener

G. Drying/Dehydration:

1. Mechanical (Cabinet) drier
2. Solar drier
3. Spray drier
4. Sulphur fumigation chamber

5. Vacuum drier
6. Freeze drier

H. Oil extraction

1. Mechanical decorticator
2. Power ghani (oil press)
3. Table oil expeller
4. Filter Press
5. Pouch packing machines

I. Instruments for analytical purposes

1. Refractometer
2. Salometer
3. pH meter
4. Pressure tester
5. Pipette
6. Burette
7. Conical flask
8. Beaker
9. Volumetric flask

J. Common chemicals

1. Citric acid
2. NaOH (Sodium hydroxide)
3. Sodium Benzoate
4. Alcohol (Rectified spirit)
5. Pectin
6. Salt
7. KMS (Potassium meta-bi-sulphite)
8. Acetic acid
9. Coal tar dyes (carmosine, Tatartrazine)
10. Flavour/Essences, (apple, peach, mixed fruit, strawberry essence, raspberry essence, orange and alphonso essence etc.)

Ex. No. 2 **Date :**

OPERATION OF DIFFERENT MACHINERIES & MACHINERIES AND EQUIPMENT'S FOR CANNING INDUSTRIES

Brief detail and operation of different machineries

1. Belt Conveyor: The conveyers are suitable for feeding, inspection and initial preparation of fresh fruits and vegetables. It can handle 1-10 tonnes of material per hour.

2. Fruit and vegetable washers: This machine is useful for washing the fruits and vegetables. The capacity varies between 15 to 20 kg per batch with a cycle time of 5 to 10 minutes depending on condition of fruit or vegetable. It is made of stainless-steel tank with wire mesh basket, water circulation pump and agitation equipment and works with 3 HP motor. For washing, the commodities are subjected to strong water agitation for removing the dirt and dust. Roller brushers are used for proper washing. Fresh water is also sprayed in the second stage washers.

3. Halving and burring Machine: The halving and burring machine is used to extract juice from citrus fruits like orange, mosambi, grapefruit, lemon (Hill lemon), lime etc. The fruit in a cup of machine is cut into two halves by a stationary or revolving knife. The burrs (roses) are made of stainless steel, aluminium or non-odorous wood. They are conical shape and are ribbed. The fruit half is held against the revolving burr and the reamed juice is collected in a vessel. By regulating the speed of burr and the pressure on the fruit held against it, optimum juice recovery can be obtained besides avoiding extraction of oil, which may otherwise cause bitterness in the juice.

4. Fruit grater: The fruit grater is used for grating/crushing of fruits for its further use in extraction of juice by passing through a basket or hydraulic press. The grater consists of a heavy steel cylinder fitted with cirrated knives with moving hammer. Apples are fed whole or halves into the hopper and are crushed between cylinder and knives and crushed material fall into a receptacle below. Other fruits like pear, carrots, aonla after removal of seeds etc can also be crushed in the grater.

5. Fruit crusher: The crusher consists of two fluted or grooved roller made of wood, and revolves towards each other arranged horizontally. The fruit fed through the hopper, falls between the rollers and get crushed. The grapes are crushed by using grape crusher.

6. Juice extractor (Hand operated): The machine is used to extract the juices from soft fruits like orange, grapes etc. The machine is conical screw feeder type with top feeding arrangement

and bottom discharge separately for juice & pulp. All the contact parts are made up of stainless steel. The capacity of the machine is 30 -50 Kg/h.

7. Basket/hydraulic press: The basket press consists of a strong cylindrical basket made of wood and rests on a wooden or metal base on a frame. There is a strong screw at the top of the frame. The sliced fruits are folded in a nylon cloth and placed inside the basket alongwith wooden frame. The screw is turned either by hand or fruit pieces are pressed by using a hydraulic pressure exerted by the hydraulic press which cause the juice to ooze out with a hydraulic pump. The basket/hydraulic press is useful in extracting juice from the apple, pear, grape, jamun, pomegranates, phalsa etc.

8. Fruit and vegetable pulper: It is useful for extracting pulp of most fruits & vegetables like mango, apple, tamarind, custard apple, plum, apricot, peach, kiwi, tomato etc. They are available as coarse pulper, fine pulper, pulper cum finisher and baby pulper. The capacity varies from 50-100 kg/ h or even 500kg/h or larger depending upon type, size and quality of product. The main body (available in brush type or canvas screw type model) is stainless steel and stand is of milled steel (MS) with motor. The pulper consists of two brushes & two beaters which give a combined beating and brushing action. They are also available with four beaters or four brushes depending upon the fruits to be handled. The gap/clearance between the sieve and beaters/brushes can be adjusted to suit different sizes and qualities of products to be pulped. The sieve is provided with perforations of different sizes and is easily removable for cleaning. All contact parts are of stainless steel. All parts can be easily dismantled and reassembled to facilitate easy inspection, proper washing, cleaning and periodic maintenance. Fruit/vegetables with or without heating are fed from the hopper and after pulping action, the extracted pulp and separated seeds/peel are collected from different ends.

9. Steam jacketed kettle: It is mainly used for heating of pulp/juice, syrup, brine etc. Generally double jacketed stainless steel boiling pan is used. Steam from boiler is supplied in the space between the outer jacket to heat the inner pan in which product is placed for heating. Steam-jacketed kettles are used to prepare a variety of food products like jams, jelly, fruit drinks, sauces, ketchup etc. Different types of kettles are: steam jacketed kettle (tilting type), Steam jacketed kettle (fixed type) and fixed type kettle with stirrers.

10. Fruit and vegetable blancher/Hot water blancher: Hot water blanchers are boiling pans/tank that is used for blanching of fruit and vegetables. They are made up of stainless steel or aluminum. The steam from the boiler is connected to the blanching tank to heat the water. A

perforated basket is used to place the fruit/vegetables in the blancher for predetermined period and removing the same after the process.

In steam blanchers, the conveyor belt is used which is covered with steam chamber. The product is carried by a belt conveyor whose speed is adjustable by manual speed reducer to optimize the processing times according to the production rates. The blancher creates a heating-process, in which the products are exposed to hot steam, with an estimated temperature of 90 to 100^0C. The products are moved by a belt and proceed through the steaming process for an estimated 6-10 minutes. Belt speed and amount of steam is adjustable, enabling to customize the blanching process depending upon the commodity. The main components of the blancher are: Belt for supporting/holding the product; Electrical gear motor with variable speed; Provision for hot water/steam and its recirculation in the heat exchanger and Control panel.

11. Crown corking machine: The crown corking machine is hand operated and can cork 20-25 bottles per minute. It is suitable for sealing the juice bottles with crown corks.

12. Pilfer proof (PP) cap sealing machine: It is used for sealing of bottles in which screw type caps are used squash bottles are sealed by using PP caps.

13. Bottle washers: Bottle washers are provided with revolving brushes to which bottle/jar is placed for automatic washing action. The time-consuming part of bottle washing is rinsing out the detergent and bottle washers are used to reduce this time. They are made by soldering vertical pipes onto a larger base pipe and connecting the base pipe to a water supply. For rinsing, the bottles or jars are inverted over the vertical pipes and rinsed until free of detergent.

14. Laboratory glassware/equipment: The laboratory equipment used for testing fruit and vegetable products includes glass beakers, pipettes, flasks and a burette. Pipettes are used to suck a known volume of a chemical and drop it into a sample of juice. Care is needed not to suck chemicals into the mouth. The burette is used to accurately measure the amount of a chemical that is added to a sample of juice when testing the amount of acid in the juice. Glassware should be cleaned with detergent and bottle brushes, rinsed with clean water and then rinsed again with distilled water.

15. Refractometer: Hand refractometer measures total soluble solids (TSS) as ^{0}Brix, which corresponds to % sugar. These are available in three ranges 0-32^{0}Brix, 28-62^{0}Brix and 58-92^{0}Brix and used for measuring total soluble solids in fruit juices, sauces, syrups, jams, jellies, squashes, preserves etc. Abbe refractometer measures TSS in the range of 0-100^{o}B. Abbe

refractometer is expensive instrument but it gives an accurate measurement of TSS and can also be used for standardization of hand refractometer.

16. Weighing balance/scales: Small scales (0-2kg), medium portable scales (up to 10kg) and large scales (upto 100kg) are used to weigh small amounts of ingredients or laboratory chemicals, weighing of ingredients and products and weighing of fruit and vegetables respectively. Care is needed to properly clean scales if they have been used to weigh chemicals. The small scales can be operated using batteries or mains power supply.

Machineries and equipments for canning industries

1. Can body reformer: The cans are available in the market as in flattened form and therefore the reforming of these cans is needed. The can body reformer can reform 10-15 cans/minute. Large capacity reformers are also available.

2. Flanger: After reforming of cans, the flanging of can ends is done by using flanger machine. The ridges/ body hooks are formed on the both ends of the cans for proper sealing of cans.

3. Lid embossing/Coding machine: The embossing is done before seaming and it provides a code with the necessary information about the product like name of canning unit, product packed in the can, date of packing, lot number etc.

4. Double seamer: It is suitable for high speed air tight seaming of the open top sanitary (OTS) cans. The seaming of the cans is done for getting hermitic seal of cans. Double seaming is a two-step operation. In the first operation, the can lid is inserted on to the can body hook by holding and rotating the lid-in-position can between two rollers. This operation is called as clinching; during which first operation roller gently guides the lid in the body hook. The next step is to press the seam using the second operation roller, which results in an appropriate overlap of the body hook and cover hook to provide appropriate countersink. Between the cover hook and body hook lies a layer of sealing compound which ensures the sealing process.

5. Exhaust box: The exhaust box is suitable for exhausting the air from filled cans before seaming. The purpose of exhausting and creation of vacuum is to create an anaerobic environment inside the can that would inhibit microbial spoilage. The can covered with the lid or loosely sealed are exhausted at about 82-87^{o}C or on a moving belt through a covered steam box. The time of exhaust varies from 5 to 25 min depending upon the nature of the product. At the end of the exhausting, the temperature at the centre of the can should be about 79^{o}C.

6. Can sterilizer/Autoclave: After sealing, the cans are placed in sterilization tank for sterilization/processing of cans. Sterilization tank is made up of milled steel or stainless steel which is connected with steam pipe to supply steam from the boiler. Similarly, retort/autoclave

can also be used for sterilization of sealed cans of vegetables and mushroom which are processed under steam pressure.

Ex. No.3 **Date :**

ESTIMATION OF FRUIT FIRMNESS

Aim: To estimate the fruit firmness.

Apparatus/machineries/equipment's required:

- Magness–Taylor Pressure Tester
- Penetrometer

Theory and principle: Fruit firmness is an important feature of maturity. During ripening, fruits may soften and become too soft at the overripe stage. The changes are detected by touching or by using devices like texture analyzers and pressure testers to measure texture of fruits and vegetable.

For measurement of pressure, maximum force required to rupture the sample is measured by pushing a cylindrical metal probe into the sample to a given depth. The Magness-Taylor pressure tester can be used to determine the softening of fruits during maturity. In this instrument 10 lb or 30 lb force springs are used. Each of them is provided with one or two punches of 5/16 or 7/16 inch in diameter. The plunger of larger diameter is used on softer material, while the smaller one is used for firmer material.

Procedure for estimation

- Select the pressure tester knob according to type of fruit
- Remove a thin portion of the skin in case of waxy fruits
- Hold the plunger against the surface of the fruit and forced into the fruit with a steady pressure to attain the force necessary for breaking the flesh
- The force (lb/inch^2 or kg/cm^2) recorded on the pressure tester is used to interpret the maturity of fruits.

Observations and results

Sample No.	Pressure lb/ inch
1	
2	
3	
Mean	

Inferences

- The unripe fruits have more firmness than that of ripe fruits.
- With the increase in the ripeness of the fruit, the firmness of the fruit decreases.
- The unit for measuring the firmness are: lb/inch and kg/inch

Ex. No.4 **Date :**

ESTIMATION OF MOISTURE CONTENT AND TOTAL SOLIDS

Aim: To determine the moisture content in fresh and processed products

Principle:

Heating of sample evaporates the water from it. The weight loss due to evaporation is moisture and weight left over is the total solids.

Moisture is total quantity of water present in the sample. Total solids is the weight of sample deducting the moisture. It is measured by drying the sample at 70 ± 2^{o}C temperature in oven. The reduction in weight is computed as moisture%.

Moisture content of some fruits, vegetables and food products.

Commodity/ products	**Moisture (%)**
Apple	85-90
Avocado	65
Berries	81-90
Citrus fruit	86-89
Guava	81
Lima beans (Green	67
Melons	92-94
Olives	72-75
Raw nuts	3-5
Radish	93
Sweet potato	69
Honey	20
Grape juice	70-85
Lime juice	89-90.3
Lemon Juice	81.1-92.4
Fruit juices and nectars	85-93
Fruit Jellies, jams, Marmalade and preserve	30-35
Syrups	20-40

Apparatus/equipment's/ machinery required

- Hot air Oven
- Weighing balance

- Moisture dishes/Petri plate

Procedure:

- ❖ Dry flat bottom metallic dish or Petri plate at 100^{o}C for 1 hr, cover the dish, cool and weigh (W_0)
- ❖ Spread 10-20g sample (or 1.5g for dried products) uniformly on to the Petri dish and weigh (W_1)
- ❖ Remove the cover and dry in hot air oven at atmospheric pressure. Maintain temperature at 70^{o}C for fruits and their products or 100^{0}C in case of vegetables and their products
- ❖ Dry till constant weight is achieved. 16-18hrs are sufficient for most of the commodities
- ❖ After drying replace lid, cool in desiccators and reweigh (dish containing dried sample) (W_2)
- ❖ Ensure that the constant weight is achieved

Observations

Sample No.	Weight of sample taken (W_0)	Weight of sample + weight of moisture/petri dish (W_1)	Weight of dried sample + weight of moisture/ petri dish (W_2)	Moisture (%)	Total solids (%)
1					
2					
3					
Mean					

Calculation

$$\textbf{Moisture (\%)} = \frac{(W_1) - (W_2)}{W_0} \times 100$$

Total solids (%) = 100 – Moisture %

Ex. No. 5 **Date :**

ESTIMATION OF ASH CONTENT

Aim: To estimate the ash content in fresh and processed products.

Theory and principle: Estimation of ash contents is important as it gives an idea about the presence of minerals in the food samples. Determination of ash is also required to evaluate fruit chutneys as the maximum limit for ash in this product shall not exceed 5% as per FPO specifications.

Apparatus/instruments/equipment

- Crucibles
- Heating plate
- Muffle furnace
- Desiccators
- Sensitive balance

Procedure for estimation

1. Place the crucibles in a muffle furnace and heat at 550ºC for 15 minutes.
2. Remove the crucibles from the furnace, cool in desiccators for one hour and weigh.
3. Weigh 5 g of sample in a crucible.
4. Keep the sample on a hot plate till it becomes thoroughly charred.
5. Place the crucible inside the muffle furnace and heat to 550ºC for 5 to 6 hours.
6. Let the furnace cool and take out the crucibles containing ash which is white in colour.
7. If traces of carbon still remain, cool the crucible and break up the ash with a glass rod.
8. Place the sample again in muffle furnace at 550ºC.
9. Cool the crucible in a desiccator and re-weigh the crucible containing ash.
10. Calculate ash using standard equation.

Observation:

Sample No.	Weight of empty crucible	Weight of sample	Weight of crucible with sample	Weight after Ashing	Ash (%)
1.					
2.					
3.					

Calculations:

$$\textbf{Ash (\%)} = \frac{\text{weight of crucible with ash} - \text{weight of crucible}}{\text{weight of sample}} \times 100$$

Ex. No. 6 **Date :**

DETERMINATION OF pH IN FOOD PRODUCTS

Aim: To determine the pH of food samples.

Theory: pH is defined as the negative logarithm of its hydrogen-ion concentration in gram per litre. It can be measured by using pH meter.

The hydrogen-ion concentration of a food is a controlling factor in many chemicals and microbiological reactions. Pure water has equal concentration of H+ and OH- ions, each having the value of 1x107g/litre at room temperature that is why water is regarded as neutral. The pH of pure water is 7.0, the solution having pH below 7.0 is regarded as acidic while solution with pH above 7.0 is alkaline. Most fruits and fruit products have pH below 4.0 while vegetable, milk and meat products have pH more than 4.0 or above. Thus with the increase in acidity in the solution, the pH value decrease and vice versa. However, presence of buffer salts helps in maintenance of pH. Estimation of pH of the food is important as the processing conditions for different food products are categorized on the basis of their pH.

pH value of some fruits and processed products

Commodity	pH value	Commodity	pH value
Apple	3.2-3.7 (3.4)	Apple cider	3.3-3.5 (3.3)
Apricot	3.6-3.9 (3.7)	Apple Sauce	3.2-4.2 (3.6)
Asparagus green	5.4-5.7 (5.5)	Asparagus Puree	5.0-5.3 (5.2)
Beans green	5.2-5.7 (5.4)	Beans Puree	5.0-5.2 (5.1)
Black berries	3.3-3.5 (3.4)	Carrot Puree	4.9-5.2 (5.1)
Carrot	5.0-5.4 (5.2)	Corn, brine packed	6.1-6.8 (6.3)
Cherry	3.3-3.5 (3.3)	Cherry Juice	3.4-3.4 (3.4)
Figs	5.0-5.0 (5.0)	Cranberry juice	2.4-2.8 (2.6)
Goose berries	2.8-2.9 (2.9)	Orange juice	3.5-4.0 (3.7)
Grapes	(3.1)	Grapes juice	3.0-3.4 (3.2)
Grapefruit	3.0-3.4 (3.2)	Grapefruit juice	3.0-3.4 (3.3)
Mushroom	5.8-5.9 (5.8)	Lemon Juice	2.7-3.3 (2.9)
Peach	3.6-4.1 (3.8)	Pickle, Dill	2.6-3.8 (3.1)
Pear, Bartlett	3.6-4.7 (4.1)	Cucumber Pickle	(4.4)
Prunes	2.5-4.2 (3.7)	Pickle, Sour	(3.1)
Potato	5.4-5.6 (5.5)	Pine apple juice	3.4-3.5 (3.5)
Pineapple crushed	3.2-3.5 (3.4)	Plum, green gaze	3.6-4.0 (3.8)
Pumpkin	4.8-5.2 (3.7)	Sauerkraut	3.4-3.7 (3.5)
Raspberry	3.2-4.1 (3.7)	Spaghetti in tomato sauce	4.7-5.5 (5.1)
Spinach	5.1-5.9 (5.4)	Tomato Juice	4.0-4.5 (4.3)
Strawberry	3.0-3.9 (3.4)	Tomato Puree	4.0-4.3 (4.2)
Tomato	4.0-4.6 (4.4)		

Principle: Working of a pH meter is based on the principle of measuring the Electro Motive Force (EMF) or potential formed from a reference electrode, test solution and a glass electrode sensitive to H+ ions. The potential developed is directly proportional to the concentration of the H+ ions in the given solution.

Apparatus and reagents required

1. pH meter
2. Standard buffer solution (pH 4.0 and pH 7.0)

Procedure for measurement of pH

- ✓ Weigh a known quantity of the sample
- ✓ Macerate with known volume of distilled water
- ✓ Allow the mixture to stand for 30 minutes
- ✓ Decant the supernatant in a beaker. (In case of juice, squash, cordial, measure pH directly without dilution/maceration).
- ✓ Calibrate the pH meter with the help of standard buffer solutions (pH 4.0 and 7.0)
- ✓ Wash the electrode with distilled water and wipe with tissue paper
- ✓ Dip the electrode in the test solution; keep stirring the solution with a glass rod till a constant pH is recorded

Note: For rough measurement, the pH indicator paper can be used. Indicator papers of different pH ranges are available. The indicator paper slip is dipped in the test solution and change in colour of the paper is compared with colour of indicator paper to note the pH.

Observations:

Sample No.	pH
1.	
2.	
3.	
Mean	

Results: The pH meter directly gives the pH value of the product and can be calculated directly by taking average of three values

Ex. No. 7 **Date :**

ESTIMATION OF TITRATABLE ACIDITY

Aim: To estimate the titratable acidity of fresh and processed fruit and vegetable products.

Theory:

Most of the fruit, vegetables and their products contain acid or mixture of acids. The acids may occur naturally in the fruit and vegetables or may be added during manufacture of different products or by lactic acid or acetic acid fermentation. Generally citric acid is added in most fruit products while in pickles, sauces and ketchup acetic acid is used. The acids are mainly responsible for the tartness or sour taste, thus estimation of acidity is used as the measure of tartness. They also helps in preservation by lowering the pH of the finished products.

Principle:

Acidity in the sample is measured by titrating a given sample against a standard alkali solution of known concentration using phenolphthalein as an indicator to a light pink colour. However, for highly coloured products like tomato, mixed fruit jam, accurate determination of end point may be difficult by using indicator, thus for such samples, acidity is measured by titrating the sample against a standard alkali to a pH 8.1 using pH meter or using electrometric tetrameter or the sample is further diluted to almost colourless. The acidity is expressed in terms of predominant acid present in the product using standard expression. The list of common predominant acids and their equivalent weight present in different fruit and fruit products is as under:

Predominant acids in some fruits and processed products

Acid	Fruit/vegetable/products	Equivalent weight
Acetic acid	Sauce, ketchup, pickle in vinegar	60.05
Citric acid	Citrus fruit, most fruit products, mango,guava, Tomato	64.04
Lactic acid	Curd and sauerkraut	90.08
Oleic acid	Olive	282.46
Malic acid	Apple, pear, apricot, peach, plum, Banana	67.05
Tartaric acid	Grapes, tamarind	75.04
Sulfenic acid	Onion	90.15
Sulphuric acid	Garlic	98.07

Apparatus, reagents and glassware required

1. Sodium hydroxide - 0.1 N
2. Phenolphthalein solution -1.0 %

3. Volumetric flask - 100 ml capacity
4. Conical flask - 250 ml capacity
5. Burette - 10-100ml capacity
6. Magnetic stirrer
7. pH Meter

Preparation of reagents

1. N/10 Sodium hydroxide: Dissolve 40.005g NaOH pellets in water and dilute to one litre in a volumetric flask. Standardize by titrating against standard H_2SO_4 solution (N/10). For standardization of H2SO4 against Sodium carbonate (Na_2CO_3), heat analytical grade Na_2CO_3 at 105^0C for 8 hours.
2. N/10 Na_2CO_3 Solution: Pipette 25ml of 0.1 N H2SO4 solution into 250ml conical flask. Add about 100ml water and few drops of bromophenol blue. Add standard 0.1 N Na2CO3 solution from burette to a blue end point or pH 4.1 using pH meter.
3. 1% Phenolphthalein solution: Dissolve 1g phenolphthalein in 100ml ethanol.

Sample preparation: Crush the sample (fruit, vegetable, jam, pickle etc) in a blender or pestle & mortar and mix thoroughly to obtain pulp. Weigh the material, add some water and boil for 1hr replacing the water lost in evaporation. Cool and transfer to a volumetric flask, make up to a known volume. Filter if necessary. For juice, squash, cordial etc dilute (if necessary) without boiling or crushing.

Procedure for determination of acidity

- Dilute an aliquot of sample to known volume and place in titration flask.
- Add few drops of 1% phenolphthalein as an indicator
- Titrate with N/10 NaOH to faint pink colour using burette or pipette.
- Note the titre value and calculate % titratable acidity as predominant acid.

Note: For highly coloured products, dilute small volume of the sample (5 ml) with large volume of distilled water (300-400ml). The colour becomes so pale that the indicator colour change during titration can be observed easily.

Procedure for determining acidity of coloured products using pH meter:

- Pipette 10ml of sample in 250ml beaker and add 90ml distilled water.
- Agitate diluted sample using magnetic stirrer.
- Immerse electrode of pH meter into the solution and titrate with N/10 NaOH from a burette to a pH value 8.1. At this pH, phenolphthalein turns from colourless to pink.
- Note the titre value and calculate titratable acidity as percent of predominant acid.

Observations

Sample No.	Weight of sample taken	Volume made up	Volume used for estimation	Volume of NaOH used	Titratable acidity (%)
1.					
2.					
3.					
Mean					

Calculation

$$\% \text{ Acidity} = \frac{\text{Titre} \times \text{normality of alkali} \times \text{volume made} \times \text{equivalent weight of acid} \times 100}{\text{Wt of sample} \times \text{volume of aliquot} \times 1000}$$

Ex. No. 8 **Date :**

ESTIMATION OF ASCORBIC ACID

Aim: To estimate ascorbic acid in fresh and processed fruit and vegetable products.

Theory and Principle: Fruit, vegetables and their products are important sources of ascorbic acid. The ascorbic acid is present in sufficient quantity in aonla, guava, grapefruit, lemon, pineapple, strawberry fruits etc. Barbados cherry is the chief source of vitamin C. The products manufactured from these fruits are also considered as rich in ascorbic acid and the contents available in the commodities can be detected by using 2, 6 dichlorophenol - indophenol visual titration method.

2, 6 dichlorophenol - indophenol visual titration method: The method is based on reduction of 2, 6 dichlorophenol – indophenols dye. The dye, which is blue in alkaline solution and red in acidic solution, is reduced by ascorbic acid to a colourless form. The reduction is quantitative and specific for ascorbic acid in solutions in the pH range of 1.0 - 3.5. In estimation of ascorbic acid, the prepared sample is titrated against standard 2, 6 dichlorophenol – indophenols dye to a pink end point. The titre is then used to calculate the ascorbic acid in the sample.

Apparatus, reagents and glassware required

1. 3% metaphosphoric acid (HPO_3): Dissolve 3g sticks of HPO_3 in distilled water (100 ml). prepare 1 litre solution of 3% HPO_3 as it also required in sample preparation, 0.1% oxalic acid can also be used in place of metaphosphoric acid.
2. Ascorbic acid solution: Weigh 100 mg L-ascorbic acid and dissolve in 3% HPO_3 and make volume up to 100 ml with HPO_3. Dilute 10 ml to 100 ml with 3% HPO_3 (1ml=0.1mg ascorbic acid)
3. Sodium bicarbonate
4. Dye solution: Dissolve 50 mg of the Sodium salt of 2, 6 dichlorophenol indophenol dye in 150 ml hot glass distilled water containing 42 mg of Sodium bicarbonate. Cool and dilute with distilled water to 200 ml. Store in refrigerator and standardize.
5. Beakers - 100, 250ml
6. Volumetric flasks - 100, 250ml
7. Measuring cylinder - 250ml
8. Pipette - 10ml

Procedure for estimation

Standardization of dye: To 5 ml of Standard ascorbic acid (1ml=0.1mg) and 5 ml HPO_3. Titrate this solution with the dye solution to a pink colour which should persist for 15 seconds. Determine the dye factor i.e. ascorbic acid per ml of the dye.

Sample preparation:

1. Fresh Fruits/vegetables: Crush/grind fruit or vegetable parts (known weight) along with 3% HPO_3, make to volume (100 ml) with HPO_3. Filter or centrifuge.
2. Fruit Juices: To 10-20 ml juice add 3% HPO_3 and make volume to 100 ml. Filter or centrifuge.
3. Solid and semi solid food: Take 10 g sample, blend with 3% HPO_3 and make up to 100 ml with HPO_3. Filter or centrifuge.]

Procedure for titration: Take (2-10ml) the HPO_3 extract of the sample and titrate with the standard dye to a pink end point persisting for at least 15 seconds. The titre of the sample should be such that titre should not exceed 3-5 ml.

Samples containing sulphur dioxide: Sulphur dioxide when present in fruit products like squash, jam, drinks etc reduces the indophenol dye and this interferes in the ascorbic acid estimation. To eliminate the SO_2 interference use formaldehyde condensation method as under:

To 10ml filtrate in a test tube, add 1ml of 40% formaldehyde and 0.1ml of HCl, keep for 10 minutes and titrate as earlier. Record titre and calculate ascorbic acid.

Ex. No. 9 **Date :**

ESTIMATION OF SALT (MOHR METHOD)

Aim: To estimate the salt contents in given samples by using Mohr method.

Theory and Principle: Common salt is used during preparation of pickles, sauces, ketchup, fruit chutney and appetizers. Besides, imparting taste, the salt in appropriate concentration also acts as a preservative. In different products, it is estimated by using Mohr method. The sample is titrated with standard solution of silver nitrate for estimation of salt by using potassium chromate as an indicator. From the titre the concentration of salt is estimated by using a standard expression.

Reagents/ apparatus/ glassware required

1. 0.1N Silver nitrate ($AgNO_3$): Dissolve 17g silver nitrate in 1 litre water.
2. Phenolphthalein: Dissolve 1.0 g of phenolphthalein in 100ml of 95% alcohol.
3. 0.1 N NaOH: Dissolve 40.005g NaOH pellets in water and dilute to one litre in a volumetric flask. Then dissolve 10 ml of the above solution to 100 ml with water to make 0.1N NaOH.
4. 5% Potassium Chromate: Dissolve 5g Potassium chromate in 100ml water.
5. Glasswares: Conical flask, beakers, volumetric flasks, pipette and burette.

Procedure for estimation of salt

1. Weigh accurately a known sample (5-10 g paste/pickle or 25g puree). Dilute with distilled water.
2. Neutralize with 0.1N NaOH using Phenolphthalein as indicator.
3. Transfer it to 250 ml volumetric flask, make to volume with distilled water and filter.
4. Take an aliquot (10 to 25ml) and titrate with 0.1N Silver Nitrate using 1ml 5% Potassium Chromate as an indicator.
5. Note the volume of silver nitrate used to produce red brown end point colour.
6. Carry out blank titration using distilled water and 1.0 ml of the indicator (excluding sample).

Observations

Sample No.	Wt. of sample	Volume made up	ml of sample taken	Titre value (sample) – titre value for blank	% NaCl
1.					

Calculation:

$$\textbf{Sodium chloride (\%)} = \frac{\text{Titre value* x N of } AgNO_3 \text{ x Volume made x 58.45 x 100}}{\text{ml of sample taken x weight of sample x 1000}}$$

***Titre value = Sample titre - blank titre**

Inference: The give sample of tomato ketchup contained 2.34% sodium chloride.

Ex. No. 10 **Date :**

Estimation of Sugars (Reducing Sugar)

Aim: Estimation of reducing sugars in fresh fruits and processed products using Lane and Eynon method.

Theory: Sugars are inherently present in different fruits and vegetables or added during preparation of different products. They are added to the fruit products to improve the taste and also to act as a preservative. Glucose and fructose in the fruits represent reducing sugars while sucrose or cane sugar added represents the non-reducing sugar. They are estimated by using Lane and Eynon method which measures sugar as reducing sugar and total sugar as invert sugar.

Principle: Invert sugar reduces the copper in Fehling's solution to red, insoluble cuprous oxide. The sugar content in a food sample is estimated by determining the volume of the unknown sugar solution required to completely reduce a known volume of Fehling's solution. Glucose and other sugars are capable of reducing oxidizing agents and are called reducing sugars and this property is used for the estimation of sugars. The cupric ion in Fehling's solution is reduced to cuprous state which precipitates as red cuprous oxide (Cu_2O). Only reducing sugars reduce the copper solution. The method is suitable for estimation of sugars in fruit and fruit products.

$CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

$Cu(OH)_2 \rightarrow CuO$ (Cupric oxide)

$2CuO + CHO \rightarrow Cu_2O$ (Cuprous oxide) + COOH

Apparatus, reagents and glassware required

Beakers - 250ml

Volumetric flasks - 250ml

Measuring cylinder- 250ml

Pipette - 10ml

Hot plate

Preparation of Reagents

1. **Fehling's solution-A:** Dissolve 69.28g copper sulphate (CuSO4.5 H2O) in water, dilute to 1 litre and filter.(Standard Fehling's solution A or 1, ampules can be used also)
2. **Fehling's solution-B:** Dissolve 346g of Rochelle salt (Potassium Sodium Tartrate, KNa C4H4O6.4H2O) and 100g NaOH in water, make volume to 1 litre. (Standard Fehling's solution B or 2, ampules can also be used)
3. **Methylene blue indicator (1%):** Dissolve 1g in 100ml water.

4. **45% neutral lead acetate solution:** Dissolve 225g of neutral lead acetate in water and make up to 500ml. It is used as clarifying agent.
5. **22% Potassium oxalate solution:** Dissolve 110g Potassium oxalate ($K_2C_2O_4$. H_2O) in water and make volume to 500ml. This is used for neutralizing excess of lead acetate.
6. Standard invert sugar Weigh 10g of sucrose into 1 litre flask, add 100ml water and 5ml concentrated HCl for hydrolysis. Allow to stand for 3 days at 20-25^{0}C or 7 days at 15^{o}C inversion to take place and then make up to volume.

Standardization of standard invert sugar: Pipette 25ml of standard invert solution in to a 100ml volumetric flask; add 50ml water and few drops of Phenolphthalein indicator. Neutralize with 20% NaOH until solution turns pink. Acidify with 1N HCl adding it drop wise until pink color disappears. Make up to 100ml with water (1ml=2.5mg invert sugar).

Standardization of Fehling's solution: Mix 5ml Fehling A + 5ml Fehling B solution in 250ml conical flask. Add 25-50ml water and heat the flask. Add standard invert sugar solution from the burette dropwise till the solution turns brick red. Add few drops of Methylene blue indicator and add drop-wise invert solution, when the blue color disappears, note the titre value of invert solution, repeat the titration and calculate factor for Fehling's solution as under:-

$$\textbf{Factor for Fehling solution(}\text{(g of invert sugar)}\textbf{)} = \frac{\text{Titre} \times 2.5}{1000}$$

Procedure for estimation of reducing sugars

Take 10-20g juice/squash/drink in 250 ml volumetric flask, add 100 ml water neutralize with 1 N NaOH. Add 2ml 45% lead acetate. Shake well and keep for 10 minutes. Add few drops of potassium oxalate solution to remove excess of lead acetate. Make volume to 250ml with water and filter.

OR

Take 10-25 g of sample (fresh fruit or fruit product) and grind in a pestle and mortar, blend in blender, add 100 ml water. Neutralize solution with 1 N NaOH. Boil gently for 1 hour with stirring. Replace water lost during evaporation, cool and transfer to 500 ml volumetric flask. Make volume 500 ml and filter through whatman filter paper.

- Pipette 100 ml aliquot from filtrate in 250ml flask, add 2 ml 45% lead acetate, let it stand for 10 minutes then add few drops of 22% potassium oxalate solution and made volume to 250 ml with water and filter.
- Add 2 ml 45% neutral lead acetate solution.

- Pipette 10ml of mixed Fehling's solution (5 ml each of Fehling A and B) and few ml of water into 250ml conical flask.
- Heat the flask containing mixed Fehling's solution on hot plate and add the sample (clarified sugar) solution drop wise from the burette/pipette till faintest blue colour remains.
- Add 2-3 drops of methylene blue indicator and complete the titration till the color changes to brick red.
- At the end point, note the readings and calculate the reducing sugars.

Calculations

$$\textbf{Reducing sugar (\%)} = \frac{\text{mg of invert sugar} \times \text{dilution} \times 100}{\text{titre} \times \text{weight of the sample} \times 100}$$

OR

$$\textbf{\% Reducing Sugar} = \frac{\text{Factor for Fehling solution} \times \text{Volume made} \times 100}{\text{Titre} \times \text{wt of sample} \times \text{ml of aliquot}}$$

Ex. No. 11 **Date :**

ESTIMATION OF SUGARS (Non-Reducing and Total Sugars)

Aim: Estimation of non -reducing and total sugars in fresh fruits and processed products using Lane and Eynon method

Theory: Glucose and fructose in the fruits represent reducing sugars while sucrose or cane sugar added to the fruit products represents the non-reducing sugar. They are estimated by using Lane and Eynon method which measures sugar as reducing sugar and total sugar as invert sugar. Non-reducing sugar is determined by subtracting the total reducing sugar from reducing sugar and multiplying the remainder with 0.95 factor.

Principle: Invert sugar reduces the copper in Fehling's solution to red, insoluble cuprous oxide. The sugar content in a food sample is estimated by determining the volume of the unknown sugar solution required to completely reduce a known volume of Fehling's solution. Glucose and other sugars are capable of reducing oxidizing agents and are called reducing sugars and this property is used for the estimation of sugars. The cupric ion in Fehling's solution is reduced to cuprous state which precipitates as red cuprous oxide (Cu_2O). Only reducing sugars reduce the copper solution.

$CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

$Cu(OH)_2 \rightarrow CuO$ (Cupric oxide)

$2CuO + CHO \rightarrow Cu_2O$ (Cuprous oxide) + COOH

Apparatus, reagents and glassware required

- Beakers - 250ml
- Volumetric flasks - 250ml
- Measuring cylinder - 250ml
- Pipette - 10ml
- Burette - 50ml
- Hot plate

1. **Fehling's solution-A:** Dissolve 69.28g copper sulphate ($CuSO_4.5\ H_2O$) in water, dilute to 1 litre and filter.(Standard Fehling's solution A or 1)
2. **Fehling's solution-B:** Dissolve 346g of Rochelle salt (Potassium Sodium Tartrate, KNa $C_4H_4O_6.4H_2O$) and 100g NaOH in water, make volume to 1 litre.(Standard Fehling's solution B or 2)
3. **Methylene blue indicator (1%):** Dissolve 1g in 100ml water.

4. **45% neutral lead acetate solution:** Dissolve 225g of neutral lead acetate in water and make up to 500ml. It is used as clarifying agent.
5. **22% Potassium oxalate solution:** Dissolve 110g Potassium oxalate ($K_2C_2O_4$. H_2O) in water and make volume to 500ml. This is used for neutralizing excess of lead acetate.
6. **Standard invert sugar:** Weigh 10g of sucrose into 250ml increase in 1 litre flask, add 100ml water and 5ml concentrated HCl for hydrolysis. Allow to stand for 3 days at 20-25^{o}C or 7 days at 15^{o}C for inversion to take place and then make up to volume.

Standardization of standard invert sugar: Pipette 25ml of standard invert solution in to a 100ml volumetric flask; add 50ml water and few drops of Phenolphthalein indicator. Neutralize with 20% NaOH until solution turns pink. Acidify with 1N HCl adding it drop wise until pink color disappears. Make up to 100ml with water (1ml=2.5mg invert sugar).

Standardization of Fehling's solution: Mix 5ml Fehling A + 5ml Fehling B solution in 250ml conical flask. Add 25-50ml water and heat the flask. Add standard invert sugar solution from the burette dropwise till the solution turns brick red. Add few drops of Methylene blue indicator and add drop-wise invert solution, when the blue color disappears, note the titre value of invert solution, repeat the titration and calculate factor for Fehling's solution as under:-

$$\text{Factor for Fehling solution (g of invert sugar)} = \frac{\text{Titre} \times 2.5}{1000} \times 100$$

Procedure for estimation of Total Sugar

1. Follow the method for preparation of deleaded samples from fruits or fruit products as explained under reducing sugars (Practical-10).
2. Take 50 ml of the clarified deleaded solution from step 1 into a 250 ml conical flask
3. Add 5 g of citric acid and 50 ml of water boil gently for 10 minutes to complete the inversion of sucrose and allow to cool.
4. Transfer the inverted solution to a 250 ml volumetric flask and neutralize with 1 N NaOH using phenolphthalein as indicator and make up the volume to 250 ml with water. Place this solution into the burette and use for filtration.
5. Pipette 10ml of mixed Fehling's solution (5 ml of Fehling's A and B) and few ml of water into 250 ml conical flask.

6. Heat the flask containing Fehling's solution on hot plate and add sample (clarified sugar) solution drop wise from the burette till faintest blue color remains.
7. Add 2-3 drops of methylene blue indicator and complete the titration till the colour changes to brick red precipitates.
8. Note the titre value and calculate the total as well as non –reducing sugars from the following equations.

Observations	**Sample No**			
	1	2	3	**Mean**
1.Weight of sample taken(ml/g)				
2. Volume made				
3.Volume of sample taken for deleading				
4.Volume made up				
5. Volume of deleaded solution taken for inversion				
6. Volume made up				
7. Titre (ml of sugar solution used in titration)				
8. % Total sugars as invert sugar				
9.% Reducing sugars (From chapter 8)				
10.% Non reducing sugars (sucrose)				
11. Total sugars.				

Calculations

$$\textbf{Total sugar as invert sugars (\%)} = \frac{\text{mg of invert sugar x dilution x dilution x 100}}{\text{titre x wt. of sample taken x Vol. aliquot taken for hydrolysis} \times 1000} \times 100$$

Sucrose or non-reducing sugar (%) = (% total sugar as invert sugar - % reducing sugar) x 0.95

Total sugar (%) = % Reducing sugars + % sucrose

Non-reducing sugars (%) = Total sugars - reducing sugar

Results: Fruit contain more reducing sugar while fruit product prepared by using cane sugar contains more non-reducing sugars.

Ex. No. 12 **Date :**

ESTIMATION OF SODIUM BENZOATE IN FOOD SAMPLE

Aim: To estimate the sodium benzoate contents in fruit and vegetable products.

Theory and Principle: Sodium benzoate is used as a class II preservative in preservation of pickles, sauces, squashes etc. Its estimation is important as the quantity of class II preservative shall not exceed maximum limit prescribed under FPO. In a sample containing NaCl, the benzoic acid is converted into water soluble sodium benzoate by addition of NaOH. When the Sodium benzoate solution is acidified with excess of HCl, water insoluble benzoic acid is formed which is extracted with chloroform. The chloroform is removed by evaporation and the residue containing benzoic acid is dissolved in alcohol and then titrated with standard sodium hydroxide.

Reagents, glassware and apparatus required

1. Sodium chloride (standard salt solution)
2. Sodium hydroxide 0.05 N: Dissolve 40.005g NaOH pellets in water and dilute to one litre in a volumetric flask. Then dissolve 5 ml of the above solution to 100 ml with water to make 0.05N NaOH.
3. H_2SO_4 and HCl,
4. Chloroform and Phenolphthalein indicator
5. Distillation flask and condensers, conical flask, volumetric flask, pipette, burette and separating funnel.

General procedure for sample preparation:

1. Mix the sample (ketchup, sauce and pickle) thoroughly and grind. Use 50-100g sample for estimation.
2. Transfer to 500ml volumetric flask.
3. Add powdered NaCl (15g) to saturate.
4. Make the solution alkaline to litmus paper by adding 10 % NaOH and dilute to 500ml with saturated salt solution.
5. Shake thoroughly and allow standing for 2 hrs with frequent shaking. Filter through Whatman No.4 paper or centrifuge.
6. For sample containing fat, extract with ether before determination.

Procedure for sodium benzoate estimation

1. Take 100 ml of filtrate in 500 ml volumetric flask.
2. Neutralize to litmus paper with dilute HCl (1+3) and add 5 ml of HCl in excess.

3. Extract carefully by mixing the sample with chloroform in separating funnel using 70 ml, 50 ml, 40 ml and 30 ml chloroform successively.
4. To avoid the formation of emulsion, shake the funnel continuously.
5. Draw off carefully clear chloroform solution after each extraction and wash the chloroform layer with water.
6. Transfer the combined chloroform extract from the separating funnel to a 250 ml conical flask. Rinse the funnel with chloroform.
7. Distill at low temperature to approximately ¼th of the original volume and evaporate to dryness at room temperature on water bath till only a few drops remain.
8. Dry the residue overnight in desiccator containing H_2SO_4 (until no acetic acid odour is detected in ketchup sample) and dissolve in 50 ml alcohol.
9. Add 12-15 ml of water and 1-2 drops of phenolphthalein indicator and titrate against 0.05 N NaOH.
10. Calculate using following expression and express as ppm sodium benzoate or benzoic acid.

Observations

Sample No.	Weight of sample	Volume made up	Volume of sample taken for estimation	Titre value	ppm of anhydrous sodium benzoate	Benzoic acid (ppm)
1						
2						
3						
Mean						

Calculations:

1ml of 0.05N NaOH = 0.0072g of anhydrous Sodium Benzoate

$$\textbf{Anhydrous sodium benzoate (ppm)} = \frac{\text{Titre} \times \text{N of NaOH} \times 144 \times \text{Vol. made up} \times 1{,}000{,}000}{\text{Vol. of sample taken for estimation} \times \text{Wt. of sample} \times 1000}$$

$$\textbf{Benzoic acid (ppm)} = \frac{\text{Titre} \times \text{N of NaOH} \times 122 \times \text{Vol. made up} \times 1{,}000{,}000}{\text{Vol. of sample taken for estimation} \times \text{Wt. of sample x } 1000}$$

Ex. No. 13 **Date :**

ESTIMATION OF SULPHUR DIOXIDE

Aim: To estimate the level of sulphur dioxide contents in fruit and vegetable products

Theory and principle:

Sulphur dioxide in food product is added as class II preservative and may exists as undissociated sulphurous acid, as free bisulphate or sulphite ions or as combined SO_2 in the form of hydroxy sulphonates. Sulphur dioxide is measured as free or total SO_2. Estimation of SO_2 in squashes, jam, RTS drinks is important as its presence beyond the prescribed FPO limits make the product not confirming to Indian Food Laws. Generally 2 parts of KMS (Potassium metabisulphite) releases one part of SO_2 explained as under:

SO_2 is added in the form of potassium meta-bisulphite (KMS)

$$K_2S_2O_5 = 2(SO_2) + K_2O$$

$$(39x2) + (32x2) + (16x5) = 2(32+32)$$

$$78+64+80 = 2(64)$$

$$222 = 128$$

$$\textbf{\% } SO_2 \textbf{ in KMS} = \frac{128 \times 100}{222} = 57.70\%$$

Thus, 1g of KMS releases 0.57g of SO_2.

Free SO_2 is measured by direct titration with iodine. In the estimation of total SO_2 the combined SO_2 is liberated by treatment with excess alkali at room temperature, subsequent acidification to prevent recombination and titration with iodine. The method used is known as Modified Ripper Titration Method.

Reagents, glassware and apparatus required

1. Diluted H_2SO_4 (1+3): 1 part H_2SO_4 in 3 parts of water
2. 0.02 N Iodine solutions: Dissolve 2.53g of iodine in a solution of 24g potassium iodide in 200ml water and dilute to 1 litre (Standard Iodine solution in ampoule can also be used).
3. 1% Starch indicator: Mix 1 g soluble starch with 15 ml of cold water and pour into 100 ml of hot water. Boil for 1-2 min.
4. Sodium carbonate
5. 5 N NaOH: Dissolve 200 g NaOH pellets in water and dilute to 1 litre in a volumetric flask. Standardize by titrating against standard H_2SO_4 solution.

6. Formaldehyde (36-40%)
7. Conical flask, volumetric flask, beaker, pipettes and burette.

Procedure: For estimation of Free SO_2

1. Take known weight (10-20 g) of sample (juice, squash, jam, pulp etc.) in two separate flasks.
2. Add 5 ml of diluted H_2SO_4 (1+3) to each to acidify.
3. Add 0.5 g sodium carbonate in the first flask to expel the air present in the sample
4. Add 5-7 drops of starch solution as an indicator.
5. Titrate immediately with 0.02 N iodine solution to blue colour end point, record titre value as 'a'.
6. To determine the titre due to iodine reducing substances other than SO_2, acidify a similar aliquot of substance with 5ml of diluted H_2SO_4 (1+3).
7. Add 10 ml of formaldehyde in the second flask and allow to stand for 10 minutes.
8. Add starch solution as an indicator and titrate against iodine to a faint permanent blue colour and record titre value as 'b'
9. Record volume of iodine used by free SO_2 present in the sample by subtracting titre b from titre a, ('a-b') and calculate free SO_2 as per given expression.

Procedure for estimation of Total sulphur dioxide

1. From the same sample taken for free sulphur dioxide, take a known volume of the sample in two flasks and add 5ml of 5 N NaOH to each.
2. Stir gently and allow standing for 20 minutes.
3. To one of the sample add 7 ml of 5 N HCl.
4. Add 1 ml of 1% starch solution as an indicator and titrate immediately against 0.02 N iodine to a definite dark blue colour.
5. Record the titre value as 'c'. This titration indicates the total iodine reducing value of the sample.
6. To determine the reducing substances other than sulphites like ascorbic acid acidify the second sample in the same way with 5 ml of diluted H_2SO_4.
7. Add 10 ml of formaldehyde (36-40%) to bind the sulphite and allow the sample to stand for 10 minutes.

8. Add starch solution as indicator and titrate rapidly with constant stirring (or use mechanical stirrer) against 0.02 N iodine solution until a dark blue colour appears which persists for atleast 15 seconds.
9. Record the titre value as 'd'
10. Calculate the volume of iodine used by the total SO_2 present in the sample by subtracting titre d from titre c ('c-d)'

Observations

Sample No.	**Weight of sample**	**Titre 'a' ml**	**Titre 'b' ml**	**Titre Free SO_2 (a-b)**	**Titre 'c' ml**	**Titre 'd' ml**	**Titre Total SO_2 (c-d)**	**Free SO_2 ppm**	**Combined Total SO_2 ppm**
1									
2									
3									

Calculations:

1 ml of 0.02 N Iodine = 0.64 mg of SO_2

$$\textbf{Free } SO_2 \textbf{ (ppm)} = \frac{\text{Titre} \times 0.64 \times 1000}{\text{Weight of sample}}$$

$$\textbf{Total } SO_2 \textbf{ (ppm)} = \frac{\text{Titre} \times 0.64 \times 1000}{\text{Weight of sample}}$$

Combined SO_2 (ppm) = Total SO_2 - Free SO_2

Ex. No. 14 **Date :**

CANNING OF FRUITS AND VEGETABLES

Aim: To perform canning of fruit and vegetables.

Theory: Canning refers to a process which involves heating food stuff in hermetically sealed containers for a specific time at specific temperature to eliminate microbial pathogens that endanger public health as well as micro-organisms and enzymes that deteriorate food during storage. Broadly canning is a method of preservation of food for achieving longer shelf-life. Principle of canning: Destruction of spoilage causing micro-organisms and enzymes within the sealed containers by means of heat.

Machinery/equipments required for canning

1. Can Reformer, Flanger, Double Seamer, Exhaust box, Sterilization tank, Retort, Lye peeling tank and Coding Machine, Refractrometer, gas Bhatti /Boiler.
2. Empty flat cans of A1 tall or A2½ size.
3. Fruits and vegetables suitable for canning
4. Peeling and coring knives
5. Salt or sugar
6. Sodium hydroxide

Canning process: Canning consists of selection of commodity, washing, sorting, grading, peeling, halving, blanching, filling in cans, exhausting, processing, cooling, labeling and storage

1. Raw material selection: Select ripe but firm, evenly matured fruits, free from blemishes, insect damage and malformation. Select vegetables when tender except tomatoes.

2. Washing: Wash the fruits/vegetables with running water to remove dust, dirt, debris and any adhering surface micro-flora.

3. Sorting and grading: Sort out any bruised, inferior or damaged fruits either manually or by using sorting belt.

4. Peeling, coring and pitting/halving: Lye peel peaches, apricot, sand pear by placing in boiling 2% sodium hydroxide solution followed by dipping in 1-2% citric acid or 0.5% HCl solution to neutralize lye then wash in running tap water.

- Peel apple manually and slice. Keep in 2% salt solution to avoid browning.
- Cut peeled peaches and apricot into halves and remove the pit/stone. Keep dipped in 2% salt solution to check browning.
- Cut whole pineapple into 5mm thick slices, remove peel and core by using pineapple corers.

- Peel potatoes manually or using abrasive peeler and cut into slices. Keep slices in 2% salt solution to check browning.

5. Blanching: Place mushroom and vegetables in boiling water or in blanching tank for 2-5 minutes followed by dipping in cold water for blanching.

6. Preparation of cans

- Reform the flattened cans using reforming machine.
- Flange in a Flanger.
- Place lid/ end cover on one side of can using double seaming machine.
- Sterilize can in can sterilizer or place in boiling water.

7. Filling into cans

- Place uniform sized peaches/apricot/pear/halves, pineapple slice into lacquered cans to its declared drained weight (not less than 50%). (Generally from one kg of peach fruit, one can of A 2 ½ size is obtained).
- Fill mushrooms and vegetables (peas, okra, potato) in cans of not less than 55% of the total capacity of the can.

8. Syruping: Prepare syrup by boiling sugar and water, followed by straining. Keep concentration of sugar as 35-55%.

- Use 40% sugar syrup containing 0.3% acidity for peach canning. Fill the cans with boiling hot syrup.
- Add the syrup or brine in the can at a temperature of 79-82^{O}C, leaving 0.32-0.47cm head space.

9. Brining: Prepare hot brine by boiling salt and water (2-10%) along with citric acid (0.3%) and sugar (1%) followed by straining and pour in the can containing vegetable while still hot.

10. Exhausting: Immediately after filling of syrup or brine, place loose lid/ end cover on the can or clinch the can using first operation roll of the double seamer. (The lid/ end cover should be embossed with a coding machine). Place in a hot water tank or in a exhaust box for exhausting. Exhaust the cans till a temperature at the centre of can reaches 79^{o}C.

11. Double seaming: Immediately after exhausting, seal the cans using double seamer.

12. Heat Processing/sterilization

- Place the sealed cans in boiling water in sterilization tank for 25-30 minutes depending upon the type of fruit being canned.
- Process canned vegetables in autoclave at 10-15 psi pressure (116-121^{o}C) for 25-30 minutes.

13. Cooling: Cool the heat processed cans immediately in cold running tap to about 35-40^{o}C to prevent stack burning.

14. Storage

- Stack cans one above other to allow the outer surface to dry to avoid rusting.
- Keep the cans for about a week in the store.
- Label the cans manually or by using labeling machine.
- Store in cool and dry place.

FPO specification for canned fruits and vegetables

Specifications	**Canned fruits**	**Canned vegetables**
Drained weight	Not less than 50% Exception: berry fruits 40%	Not less than 55% Exception: canned tomato 50%
Appearance	Free from blemishes, stalks, leaves, *etc*.	Free from pods, stalks, roots and blemishes *etc*.
Texture	Free from disintegration and damage from bruises.	Free from disintegration and damage from bruises.
Added colour	No colour except strawberry and cherry	Not permitted, except for peas
Organoleptic quality	Characteristic taste	Characteristic taste
Preservatives	Not permitted	Not permitted
Incubation condition	No positive pressure when incubated at 37^{o}C for one week	No positive pressure and sign of bacterial growth when incubated at 37^{o}C and 55^{o}C for one week.

Ex. No. 15 **Date :**

CUT OUT ANALYSIS OF CANNED FOODS

Aim: To conduct cut out analysis of canned fruits and vegetables products.

Theory: Cut out examination of canned products is conducted to evaluate the product whether conforming to FPO standards or not. Canned fruit and vegetables are evaluated for presence of vacuum or pressure in the can, drained weight, total soluble solids, presence or absence of preservative, internal condition of can product contents and presence or absence of fermentation for ensuring microbiological safety.

Reagents/glassware/apparatus required

1. Can opener
2. Balance for estimating drained weight
3. Head space gauge
4. Vacuum cum Pressure gauge
5. Thermometer
6. Refractometer, hydrometer or salometer
7. Sieve of 20.3 cm having o8meshes per 2.5cm.

Procedure for cut out analysis

A. External/physical examination of unopened can

1. Note the gross weight of the can.
2. Note the label information from the label of the can. Compare the label with requirement as per FPO.
3. Note the external condition of can like dents, rusty spots, scratches, leakage around seams and condition of ends as per following classification.
    - **Flat:** A can where both ends are concave. The vacuum is high enough to maintain the ends concave. (Flat can is considered optimum condition of can).
    - Flipper: A can where vacuum is so low that mechanical shock will produce distortion of one or both ends. (Not desirable)
    - **Springer:** A can in which one end is distorted and the other end is flat and pressure on the convex end will cause the flat end to spring out when pressed. (Not desirable)
    - **Swell:** A can in which both ends are convex i.e. in which there is a sufficient pressure to cause permanent distortion of both ends. (Not desirable and should be discarded)
4. Note vacuum/pressure in the can by inserting vacuum/pressure gauge. (Can with good vacuum is desirable, can showing pressure is not desirable).

B. Internal examination of can

1. Open the can with a can opener
2. Note the appearance on the surface.
   - See for under filling and over filling of cans.
   - Cloudiness in syrup: Note colour, clarity and flavour of syrup or brine.
   - Use refractometer for measuring 0B and salometer for percent salt
   - Note appearance of the material filled, record as satisfactory or unsatisfactory
3. Gross head space: Measure with seam checking gauge or head space gauge.

C. General examination of canned products: Record the following and compare with the requirements.

- Net weight or volume of contents
- Net volume of contents in relation to capacity of can
- Vacuum/ pressure: No positive pressure at sea level
- Head space: Not more than 1.6 cm (0.63 inch)
- Internal appearance of can Examine the internal surface of can after emptying and washing. See for evidence of corrosion, blistering, defects in lacquer, scratching, discoloration, leaks etc.)
- Tin content: Not more than 250 ppm (Determine using standard method)
- Examination of spoilage: No sign of swelling when cans are incubated at 37ºC for fruits and 55ºC for vegetables for 7 days.
- Fruit/ vegetable contents: Evaluate the sensory parameters like colour, firmness, flavour and overall acceptability.

Vacuum/pressure determination

- Use gauge which indicates both vacuum and pressure.
- Pierce the hollow pointed end of the gauge through the lid so that rubber gasket makes a gas tight seal and prevents the loss of vacuum.
- Moisten the rubber before applying the gauge and pierce the can with the gauge towards one edge.
- The vacuum or pressure is indicated by a needle on the dial of the gauge.
- Note the vacuum in (inches of Hg) and pressure (lb/in^2) or kg/cm^2.
- Do not measure pressure of swollen cans.
- The vacuum varies with altitude, storage temperature and head space volume.

- Generally cans should not show any positive pressure at sea level.

Drained weight: The sample is drained on a standard mesh size sieve and weighed. The drained weight is the weight of the sieve and the contents after draining minus the weight of the dry sieve. Net weight of contents: Wash the inside of the can with water, dry and note the tare weight of the empty can. Subtract the tare weight from gross weight to get the net weight of contents.

Procedure for determining drained weight

- Weigh the unopened can; open and pour the entire contents on a circular sieve without disturbing the product, incline the sieve to facilitate draining of syrup/brine.
- In case of products with a cavity such as peach, apricot, guava, pear halves, invert the cups /halves down on the screen so that the liquid can drain out but the product should not be disturbed. (Use circular sieve containing 8 meshes to 2.5 cm i.e. 0.097 inch openings. For A 2 ½ (401×411) size can use sieve of 8 inches in diameter. For A 10 can use sieve of 12 inch in diameter. For tomatoes, use sieve containing 12 meshes to an inch i.e. 0.446 inch opening.
- Drain for five minutes.
- Weigh the drained product from the sieve.
- Empty the can and take the tare weight of can including ends.

Calculate net weight and % drained weight as under:

$$\textbf{Drained weight (\%)} = \frac{\text{Drained weight}}{\text{Net weight of content}} \times 100$$

Net weight of contents = Gross weight of can - Tare weight of empty can

Estimation of vegetable contents in sauce

- Empty the contents of the can on the sieve
- Wash the contents with water to make free of sauce
- Note the weight of the sieve and washed vegetable
- Subtract the weight of the dry sieve and calculate the vegetable content as percentage of the net weight of the contents of can.

Estimation of foreign matter in cans

- Note for presence of foreign matter such as flies, ants, maggots, leaves, straw, hair etc. in the can. Their presence indicates gross carelessness and working under un-hygienic conditions.
- The micro-organisms growing at 37^{o}C usually cause spoilage accompanied by the production of gas (CO_2) which causes the cans to become ‘springers’ or ‘hard swell’.
- A can which swells at 37^{0}C indicates presence of living mesophilic organism usually caused by leakage.
- At 55^{o}C, cans do not generally swell. Spoilage causing micro-organisms are flat sour type and they do not grow at low temperature.

Ex. No. 16 **Date :**

PREPARATION OF SQUASH

Aim: To prepare squash from fruits or fruit pulp.

Theory: Squash is a type of fruit beverage containing at least 25% fruit juice or pulp and 40% total soluble solids (TSS). Squash is diluted before serving (1:3). According to FPO specifications, class II preservative in fruit squash shall not exceed 350 ppm sulphur dioxide or 600 ppm sodium benzoate. Artificial colour and flavours can be added when declared on the label.

Raw material, ingredients, machinery and equipment's required

1. Fruits like mango, orange, lemon, lime, litchi, pear, apricot and pineapple are used for making squash.
2. Machineries and equipments like pulper, juice extractor, pan and refractometer.
3. Stainless steel knives, de-corers, ladle and utensils for cooking and mixing, glass bottles, sterilization tank, LPG stove/diesel bhatti etc.
4. The recipe for preparation of squash from different fruits is given in Table

Recipe/ingredients required for preparation of squashes from different fruits

S.No.	Fruit pulp/juice (1kg)	Ingredients for one litre pulp/juice			
		Sugar (kg)	Water, (Lts)	Citric acid (g)	Preservative (g)
1	Mango	1.80	1.2	35	2.0 KMS
2	Apricot	1.80	1.2	25	1.5 KMS
3	Lemon, Lime	1.80	1.2	-	1.5 KMS
4	Litchi	1.80	1.2	25	2.25 KMS
5	Orange	1.75	1.2	20	2.5 KMS
6	Pineapple	1.75	1.2	20	2.0-2.5 KMS
7	Papaya	1.80	1	25	2.5 KMS
8	Jamun	1.80	1	15	3.0 Sod. benzoate
9	Plum	1.90	1	10	4.0 Sod. benzoate
10	Watermelon	0.50	0.25	10	1.5 Sod. benzoate

Procedure for preparation of fruit squash

1. Extraction of pulp/juice

i) Lime and lemon: Take fresh, fully ripe, sound fruits and wash them in fresh water. Cut them into halves with stainless steel knife. Express juice with juice squeezer and strain through muslin cloth to remove seeds. (Rosing machine can also be used for juice extraction).

ii) Orange*: Peel oranges, separate segments, pass segments through screw type juice extractor. Collect juice and strain through muslin cloth.

iii) Mango: Select fresh and ripe fruits. Wash in fresh water and extract the pulp by pressing in hands or extract pulp by passing through the pulper.

iv) Litchi: Peel litchi fruits and remove seeds, extract juice by passing through juice extractor or pulper. Strain through muslin cloth.

v) Plum/apricot/jamun: Wash the fruits, boil with small quantity of water, passs through pulper to extract the pulp and separate the seeds.

vi) Papaya/watermelon: Peel fruits, separate seeds, pass through pulper to extract the pulp.

vii) Pineapple: Remove the crown of fruits by giving twist, remove peel and eyes. Cut the sound portion into small pieces, pass them through a mincer. Wrap the pieces in muslin cloth and press out the juice through basket press. Strain the juice through coarse muslin cloth.

2. Preparation of syrup: Prepare sugar syrup by mixing sugar, citric acid with water. Heat to boil, strain through muslin cloth and allow to cool.

3. Mix fruit pulp or juice with the required quantity of sugar syrup.

4. Add required quantity of KMS or sodium benzoate along with permitted edible food colour and flavour and mix thoroughly.

5. Fill in per-sterilized glass or plastic bottles leaving a small head space (2.5 cm).

6. Cap and seal bottles using PP cap sealing machine.

7. Label and store in cool and dry place.

***In case of orange juice, the removal of astringency is important. For this purpose, dip the segments in hot 2% NaOH for 2-3 minutes followed by dipping in 0.5% citric acid solution. This treatment results in removal of astringency.

FPO Specifications for Squash

Juice content	- Not less than 25%
Total soluble solids	- Not less than 40%
Acidity	- Not more than 3.5%
Preservatives	- Sulphur dioxide (Not more than 350 ppm) - Benzoic acid (Not more than 600 ppm)
Synthetic sweetening agent	- Not permitted
Fermentation test	- Negative at 37ºC
Organoleptic quality	- Free from objectionable taints and flavour

Ex. No. 17 **Date :**

PREPARATION OF CORDIAL

Aim: To prepare cordial from lemon and lime.

Theory: Cordial is a sparkling, clear, sweetened fruit beverage from which pulp has been removed completely. It contains at least 25% fruit juice, 30% total soluble solids (TSS), 1.5% acid and 350 ppm sulphur dioxide. Lemon and lime juice cordials are the commercial products.

Raw material, ingredients and utensils required

- Lemon and lime are used for making cordial.
- Stainless steel knives, juicer/screw type juice extractor, utensils for cooking and mixing, glass bottles, sterilization tank etc
- Recipe for preparation of cordial

Lime/lemon juice 1 litre; Sugar 1.40 kg; Water 1.6 litre; Potassium meta-bisulphite (KMS) 1.5 g

Procedure for preparation of fruit juice cordial

1. Extract the juice from lime or lemon as in case of squash and store in glass bottles after adding potassium metabisulphite @ 1.5g/kg of the juice.
2. Allow the juice to settle for a month.
3. Decant the clear juice without disturbing sediments and strain it through fine muslin cloth.
4. Prepare sugar syrup by mixing sugar in water, heat, filter and cool.
5. Mix clarified juice in syrup to prepare cordial.
6. Strain the cordial through muslin cloth if necessary.
7. Add KMS and fill into bottles.
8. Synthetic flavour/ emulsions can also be added when declared on the label.
9. Store in cool and dry place.

Note: Juice can also be clarified by using tannin-gelatin mixture.

FPO Specification for cordial

Juice content	- Not less than 25%
Total soluble solids	- Not less than 30%
Acidity	- Not more than 3.5%
Preservatives	- Sulphur dioxide (Not more than 350 ppm) - Benzoic acid (Not more than 600 ppm)
Synthetic sweetening agent	- Not permitted
Clarity in cordial	- Clear, free from pulp and other cellular matter
Fermentation test	- Negative at 37ºC
Organoleptic quality	- Free from objectionable taste and flavour

Ex. No. 18 **Date :**

READY TO SERVE (RTS) DRINK/SWEETENED JUICE

Aim: To prepare ready to serve drink from fruits.

Theory: Ready to serve (RTS) drink is a type of fruit beverage which contains at least 10% of fruit juice and 10-degree Brix total soluble solids (TSS) with 0.3% acidity. It is not diluted before serving; hence it is known as ready to serve beverage. Mango drink, guava drink, pineapple drink are the commercial products available in the market. Sweetened fruit juice is categorized as ready to serve beverage in which the minimum juice content shall be 85% with a minimum TSS of 10%, while unsweetened juice is a natural juice having 100% fruit juice with natural total soluble solids. These are preserved by heat processing method. Sweetened apple, pear juices are commercially manufactured.

Raw material, ingredients, machinery required

- Mango, orange, lemon, lime, litchi, pear, kiwi and apricot are used for making RTS.
- Stainless steel knives, juicer/screw type juice extractor, utensils for cooking and mixing, glass bottles, sterilization tank, gas bhatti etc
- Recipe for preparation of RTS from different fruits:
    - ❖ Pulp/juice 1.5 litre
    - ❖ Sugar 685 g
    - ❖ Citric acid 3.5g
    - ❖ Water 7.8 litre
    - ❖ Potassium meta-bisulphite 1.5g (KMS)

***Note:** RTS drink can also be preserved by adding not more than 70 ppm SO_2 or 120 ppm benzoic acid.

Procedure for preparation of ready to serve (RTS) drinks

- Take fruit pulp/juice and mix with syrup which is prepared by mixing sugar with water and citric acid
- Homogenize the mixture for proper mixing
- Heat the drink to boil for pasteurization
- Fill in the glass bottles (200ml capacity) while still hot
- Crown cork the bottles and process in boiling water for 20-25 minutes
- On cooling, label the bottles and store in cool and dry place
- Potassium meta-bisulphite (KMS) or benzoic acid can be added to the RTS drink as preservative

- Synthetic and approved artificial colour and flavour can be added when declared on the label

FPO specifications for Ready to serve drinks

Juice/pulp content	Lime - Not less than 5% Other fruits - Not less than 10%
Total soluble solids (TSS)	Not less than 10%
Preservatives	Sulphur dioxide - Not more than 70 ppm Benzoic acid - Not more than 150 ppm
Synthetic sweetening agent	Not permitted
Colour and flavour	Only approved artificial colour and flavour should be used and mentioned on the label
Acidity	Not more than 3.5%
Incubation condition	No positive pressure/sign of bacterial growth when incubated at 37^0C for one week

Ex. No. 19 **Date :**

PREPARATION OF FRUIT NECTAR

Aim: To prepare nectar from different fruit pulp/juice.

Theory: Fruit nectar is also a RTS drink but it contains not less than 15^0Brix TSS and not less than 20% fruit juice or pulp. It is preserved only by heat processing as such no preservative is allowed in fruit nectars. Mango nectar, guava nectar etc. are the commercial products in this category.

Raw material, ingredients and utensils required

- Mango, guava, and pineapple nectars are commercially available in the market. However the nectar can also be prepared from a number of other fruits like jamun, aonla, apricot, papaya, plum and bael etc.
- Stainless steel knives, juicer/screw type juice extractor, utensils for cooking and mixing, glass bottles, sterilization tank, gas bhatti etc.

Recipe: Generalized recipe for the preparation of nectar consists of following ingredients:

Fruit juice/pulp 1 litre/kg Sugar 500g

Citric acid 4-5g Water 2.5 litre

Procedure: Fruit nectar is prepared by following the steps

1. Wash the selected fruits.
2. Peel or cut the fully ripe fruit into slices and remove the seed.
3. Crush the pieces in to pulp and pass through a fine sieve to remove the fibrous materials or extract the pulp by passing fruits through pulper.
4. Mix pulp with water, add sugar and citric acid.
5. Mix thoroughly and strain the product through muslin cloth or homogenizer.
6. Add permitted colour not exceeding 0.02%.
7. Process/boil the nectar and fill into previously sterilized glass bottles.
8. Crown cork the bottles, process in boiling water for 20-25 minutes and air cool.
9. Store bottles in cool dry place.

FPO specifications for fruit nectars

Juice/pulp content	Orange/pineapple- not less than 40% Other fruits -not less than 20%
Total soluble solids (TSS)	Not less than 15%
Preservatives	No preservative
Synthetic sweetening agent	Not permitted
Colour and flavour	permitted only 0.02%
Acidity	Not more than 1.5%
Incubation condition	No positive pressure/sign of bacterial growth at 37^0 C for one week

Ex. No. 20 **Date :**

PREPARATION OF JAM

Aim: To prepare Jam from different fruits.

Theory: Jam is prepared by boiling the fruit pulp with a sufficient quantity of sugar to a thick consistency, firm enough to hold fruit tissues in position. For preparation of jam not less than 45 parts of fruits are used for every 55 parts of sugar. According to FPO specifications, minimum quantity of soluble solids in the prepared jam shall not be less than 68% (w/w). The jam prepared by using two or more fruit pulps, is called as mixed fruit jam. Approved fruit colour and flavour can also be added into the jam when declared on the label.

Raw material, ingredients and utensils required

- Fruits like Apple, apricot, mango, plum, peach, guava, pineapple, pear and kiwifruit etc either singly or in combination.
- Stainless steel knives, ladle utensils for cooking and mixing, glass bottles, sterilization tank, juicer/basket press, bhatti/LPG stove/boiler, Refractometer etc.
- The recipe (for 1kg fruit pulp) for different fruits is given in Table.

Recipe for preparation of jam from different fruits (basis 1 kg fruit pulp)

Fruit	Sugar, g	Citric acid, g
Apple	750	2.0
Apricot	600	1.0
Mango	750	1.5
Plum	750	-
Peach	800	3.0
Pear	750	1.5
Strawberry	750	2.0
Aonla	750	-
Mixed jam (equal amount of fruit pulp)	800	2.5

Procedure for preparation of jam: The jam from different fruits is prepared by using the steps discussed as under:

Sheet or flake test: A small quantity of jam is taken out during boiling in a spoon or wooden ladle. It is allowed to drop after slight cooling. If the product falls off like a sheet instead of flowing like syrup, indicates the end point. Otherwise, continue boiling till the sheet test is positive. OR

A drop of prepared jam if poured gently in glass tumbler full of water settles down at the bottom of tumbler also indicates the end point. In case of shattering in water further cooking is needed.

Weight Test: Generally from one kg sugar and one kg pulp approximately one and half kg jam is obtained.

Procedure for jam preparation

1. Select fully ripe fruits and wash thoroughly to remove any adhering dust and dirt.
2. Peel the washed fruits slice and cook till softening and extract the pulp. Preserved pulp can also be used for jam making.
    - Mangoes are peeled, stones separated and then sliced. The slices are then passed through a pulper.
    - Pineapples are peeled, sliced and the cores punched.
    - Apple, guava and pear after washing are cut into halves or quarter, boiled till softening and pulp extracted in a pulper.
    - Peach, plum and apricot was washed, boiled like softening and pulp extracted in a pulper.
3. Addition of sugar: Add continue cooking with stirring. Generally 55 parts of cane sugar (sucrose) is used for every 45 parts of fruit for preparation of jam.
4. Citric, tartaric or malic acid are used to supplement the acidity of the fruit for jam making. (Generally 5 g citric acid for each kg of sugar used is added to the jam). Flavours are added at the end of cooking process and just before packing
5. Only permitted colours are added not exceeding 100 ppm limit as per the Indian Food Laws.
6. Cook the mixture slowly with occasional stirring with a small quantity of water to facilitate pulping. After addition of sugar, the mixture is boiled rapidly to concentrate the soluble solids to about 68.5% in a pan made of stainless steel or aluminium.
7. Add pectin (5 g for each kg of sugar used) in powdered or liquid form just before the end point if jam is made from preserved pulp.
8. Determine the end point of jam by using a jelmeter test, ladle test or sheet test or weight test.
9. Fill the prepared jam while hot in glass jars.
10. Allow the product to cool and seal the jar air-tight. A layer of molten paraffin wax can be placed at the top of cooled jam which helps in preservation. When paraffin wax solidifies, place the lid on the jar.
11. Label and store in a cool and dry place.

FPO specifications for Jam

Fruit contents	Not less than 45% Except Raspberry and strawberry jam where it shall be not less than 25%
Total soluble solids	Not less than 68% (w/w)
Preservatives	Sulphur dioxide (Not more than 40 ppm) Benzoic acid (Not more than 200 ppm)
Synthetic sweetening agents	Not permitted
Fermentation test	Negative
Organoleptic test	Retain flavour of original fruit and free from burnt or other objectionable flavour
Crystallization	Absent

Ex. No. 21 **Date :**

PREPARATION OF JELLY

Aim: To prepare jelly from guava fruits.

Theory: Jelly is prepared by boiling the fruit with or without addition of water, straining the extract and mixing the clear extract with sugar followed by boiling the mixture to a stage at which it will set to a clear gel. The jelly should be transparent, well set, but not too stiff and having original flavour of the fruit. It should be attractive in colour and should keep its shape. In the preparation of jellies, pectin is the most essential constituent. As per FPO specifications, the quantity of fruit and soluble solids in the final product shall not be less than 45 and 65 percent (w/w) respectively. Guava jelly is the commercial product available in the market however jelly can be prepared from sour apple, karonda, jamun, loquat etc.

Raw material, ingredients, machinery required

1. Guava, sour apples, karonda, loquat etc are used for making jelly.
2. Stainless steel knives, ladle utensils for cooking and mixing, glass bottles, sterilization tank, juicer/basket press, bhatti/LPG stove/boiler, Refractometer etc.
3. The recipe (for 1kg fruit pulp) for different fruits is given in Table

Recipe for preparation of jelly from different fruits.

Fruit	Quantity	Sugar, g	Citric acid, g
Sour Apple	1kg	750-1000	3.0
Guava	1kg	750	3.0
Karonda	1kg	750	-
Jamun	1kg	750	1.0
Loquat	1kg	800	2.0

Procedure: Jelly is prepared from different fruits by using steps as detailed in Figure 21.1 and method for guava jelly is explained as under:-

Preparation of guava jelly

1. Select sound, mature fruits, wash thoroughly and cut them in small pieces along with peel (peel contains maximum pectin).
2. Cover the pieces with water and add citric acid 1.5 to 2 g/kg fruits.
3. Boil the mass gently to enable release of pectin.
4. Repeat the process 2-3 times for complete extraction of pectin.
5. Strain the mass through a muslin cloth to separate the extract.
6. Do not squeeze, only strain all the extracts and allow it to stand for settling.
7. Collect only the supernatant.

8. Perform pectin test by adding two teaspoonful of rectified spirit to a teaspoonful of extract. Formation of one big clot indicates high pectin in the extract, formation of many clots indicates medium pectin and thin gelatinous precipitates indicates poor pectin.

9. If the pectin contents are poor, concentrate the extract till it gives test of high pectin or add the pectin externally.

10. To prepare jelly from the extract cook till end point reaches. The end-point of a jelly can be judged by using any of the following methods:

Cold plate test: A drop of the boiling liquid from the pan is taken and placed on a plate and allowed to cool quickly. If the jelly is about to set, the mixture on the plate will crinkle when pushed with a finger.

Sheet or flake test: This test is more reliable than the plate test. A small portion of jelly is taken with a large spoon or wooden ladle, cooled slightly and then allowed to drop off. If the jelly drops like syrup, it requires further concentration, but if it falls in the form of flakes or sheet, the end point has been reached.

Temperature of boiling mixture: The temperature of boiling jelly during end point generally corresponds to 105.5^0C.

11. Pour the finished jelly into clean, dry, pre-sterilized jars kept on a wooden board to prevent breakage.

12. Allow the product to cool and seal the jar air-tight.

13. A layer of molten paraffin wax can be placed at the top of cooled jelly which helps in preservation

14. Label and store in a cool and dry place.

FPO specifications for jelly

Fruit contents	**Not less than 45%**
Total soluble solids	Not less than 65% (w/w)
Preservatives	Sulphur dioxide (Not more than 40 ppm) Benzoic acid (Not more than 200 ppm)
Synthetic sweetening agents	Not permitted
Fermentation test	Negative
Organoleptic test	Retain flavour of original fruit and free from burnt or other objectionable flavour
Crystallization	Absent

Ex. No. 22 **Date :**

PREPARATION OF MARMALADES

Aim: To prepare marmalade from citrus fruits.

Theory: Marmalade is a fruit jelly in which the slices/shreds of peel are suspended. The marmalades are prepared generally from citrus fruits like orange and lemon. The pectin and acid contents of the marmalades are kept slightly higher than that for jellies. They shall contain minimum of 45% fruit and 65% total soluble solids.

Raw material, ingredients, machinery required

1. Orange and lemon like citrus fruits are used for making marmalade.
2. Stainless steel knives, utensils for cooking and mixing, muslin cloth, glass jars, sterilization tank, gas bhatti etc.
3. Sugar (1:1), Citric acid 1g, shredded peel of orange 62g and flavour.

Procedure for preparation of marmalade

The marmalade is prepared by using the steps as given in flow sheet and discussed as under:

- Wash orange and lemon fruits in water and remove the thin peel.
- Cut peel into thin fine shreds using knife or shredding machine.
- Cut the peeled fruit into slices (0.3-0.45 cm thick) or crush into rough pulp.
- Boil slices gently for 30-45 minutes by simmering with 2-3 times its weight of water to extract the pectin.
- Test the extract for pectin by using alcohol test.
- Clarify or strain the extract by passing through muslin cloth or use filter aid like wood pulp or flo-supercel or use filter press to get clean extract. .
- Cut peel into 1.9-2.5cm long and 0.8-0.12cm thick shreds using knife or shredding machine.
- Soften these shreds by boiling in water for 10-15 minutes or in 0.25% sodium carbonate solution or by autoclaving at 10-15 psi steam pressure (116-121^{o}C).
- Boil the extract along with sugar (1:1) to about 103^{o}C temperature.
- Add prepared shreds to the boiling mixture.
- Continue boiling to jellying end point (check by using sheet test, drop test, weight or temperature test), total boiling time shall not exceed 20 minutes.

- Cool marmalade in a shallow pan with gentle straining to keep the shreds uniformly distributed in the marmalade. During cooling, orange peel oil can be added as an essence.
- Fill cooled marmalade in pre-sterilized glass jars.
- Place the layer of molten paraffin wax on the top surface of the jar.
- Cover the jars with lug type lids and store in a cool and dry place.

FPO specifications for marmalade

Fruit content	Not less than 45%
Total soluble solids	Not less than 65% w/w
Preservatives	Sulphur dioxide - Not more than 40 ppm Benzoic acid - Not more than 200 ppm
Synthetic sweetening agents	Not permitted
Fermentation test	Negative
Organoleptic test	Retain flavour of original fruit and free from burnt or other objectionable flavour
Crystallization	Absent

*** Sheet test:** This test is more reliable than the plate test. A small portion of jelly is taken with a large spoon or wooden ladle, cooled slightly and then allowed to drop off. If the jelly drops like syrup, it requires further concentration. Falling of the drop in the form of flakes or sheet indicates the end point.

Ex. No. 23 **Date :**

PREPARATION OF FRUIT CHUTNEYS

Aim: To conduct practical on preparation of chutney from different fruits.

Theory: Fruit chutney is made in the same way as that of jam except that spices, salt and vinegar or acetic acid is also added. In comparison to jam, chutney contains less total soluble solids than jam. The product shall be of good quality with palatable and appetizing taste. As per FPO specifications, the chutney shall contain minimum of 40% fruit (w/w) in the final product with total soluble solids not less than 50%. The acidity in the final product shall not be more than 2% with ash content not exceeding 5 percent. Mixed fruit chutney is commercially made by using different fruits in appropriate combinations.

Raw material, ingredients, equipment's and utensils required

1. Stainless steel peeling/cutting knives, pulper for extraction of pulp.
2. Utensils for cooking and mixing, ladle, glass jars, sterilization tank, diesel or LPG stove/bhatti etc
3. Mango, apple, plum, apricot and papaya etc are most common.
4. The recipe (for 1kg fruit pulp) for preparation of chutney from different fruits is given in Table

Recipe for preparation of chutney from different fruits

Ingredients	Mango	Apple	Plum	Apricot	Papaya	Mixed Fruit Apple+ Plum+ Peach 1:1:1
Sugar, g	500	500	500	750	500	750
Cumin and black pepper, g (each)	10	10	10	10	10	10
Cardamom, Red chillies, g (each)	10	10	10	10	10	10
Salt, g	40	40	40	40	40	40
Onion chopped, g	50	250	50	50	100	250
Garlic and ginger chopped, g	15	15	15	15	15	15
Vinegar, ml or Acetic acid ml	170 (6.8)	200 (8.0)	150 (6.0)	130 (5.2)	200 (8.0)	200 (8.0)
Clove (headless), No's	4-5	5	5	5	5	5
Sodium Benzoate, ppm	250	1250	250	250	250	250

***Figures in parenthesis indicate the quantity of acetic acid required**

Procedure for chutney preparation

The complete process for chutney preparation is given in flow sheet

Procedure:

1. Peel and cut selected healthy fruit into slices of suitable size.

2. Soften by dipping in boiling water along with 10% of water and pass through pulper to extract pulp or strain pulp by using strainer.
3. Mix sugar to pulp and cook on medium flame. (Slow cooking is preferred to yield better product than that of bristle heating at high temperature).
4. Add onion and garlic at the start to mellow their strong flavour.
5. Add coarsely powdered spices. Vinegar extract of spices can also be added.
6. Add vinegar just little before final stage of boiling.
7. Pack product after adding sodium benzoate in clean pasteurized jars/bottles.
8. Glass jars/bottles can also be processed at 820C for 30 minutes.
9. Cool and store in cool and dry place.
10. Label jars before sending to the market.

FPO specifications for fruit chutney

* Fruit content - Not less than 40%
* TSS - Not less than 50% (w/w)
* Total acidity - Not more than 2.1%
* Total ash - Not more than 5.1%
* Acid insoluble in HCl - Not more than 0.51 % (w/w)
* Mold count - Not more than 40% of field examined
* Preservatives - Sulphur dioxide – Not more than 100 ppm
* Benzoic acid – Not more than 250
* Sign of fermentation - Negative when incubated at 28-30^{0}C and 37^{0}C

Ex. No. 24 **Date :**

PREPARATION OF CANDIES

Aim: To conduct practical on preparation of preserve and candies from fruits.

Theory: Preserves (Murraba) are made by cooking the entire fruit or its slices/pieces in sugar syrup of higher concentration (65-70^{0}Brix). Usually for 1 kg fruit around 1.75 kg sugar is used and the cooking is continued till the TSS reaches 68%. Fruits like aonla, bael, apple, pear, karonda, pineapple and papaya etc can be used for making preserves. Aonla, bael and apple preserves are commercially available in the market.

Candies are also prepared similarly to preserve but the TSS maintained is slightly higher (75-80%). In preserve, the fruit is kept immersed in syrup and packed while in candies, the syrup is drained off and fruit pieces are further dried and packed. For candy preparation, the fruit pieces are dipped initially in 55-60% sugar solution and the TSS of the syrup is increased by 5% everyday up to 4-5 days till a TSS of 70^{o}Brix is reached. The fruit pieces are then separated from syrup, rolled in powdered sugar, dried and packed. Karonda, apple, peels of orange, lemon, grapefruit, petha (Ash gourd) and ginger etc are used for candy preparation. Petha, ginger, papaya, aonla etc candies are commercially available in the market.

Procedure for preserve and candy making

- Select healthy, mature fruits and wash in running water to remove dirt and residues.
- Peel, core and cut the fruits into pieces.
- Pricking should be done with stainless steel forks. In case of petha, after pricking place them in lime water (If slices are substantially thin, pricking may not be necessary).
- Prepare fruits for preserve and candy making by following steps as shown in Table.

Preparation of fruits for making preserve or candy.

Fruit	Step-1	Step-2	Step-3	Step-4
Aonla	Wash and prick the fruits with stainless steel fork (avoid using iron needle)	Steep in 2% salt solution for 24 hours to remove astringency	Wash and dip in 2% alum solution for 24 hours and wash	Blanch until soft but segments should remain attached
Apple/ pear	Peel, prick with fork (remove core). keep peeled fruits submersed in 2% salt solution to check browning	Steep in 2% salt solution for 24 hours to prevent browning	Wash and dip in 2% alum solution or 24 hrs and wash	Blanch in boiling water containing KMS to bleach
Bael	Remove shell, slice peeled fruit crosswise	Steep in cold water for 24 hours	-	Blanch in boiling water

	into 2.5 cm thick pieces, wash & prick			
Mango	Peel and remove green portion, cut fruit lengthwise	-	-	Blanch until soft and then prick the pieces or use thin slices
Karonda	Cut into two pieces and remove seeds	Steep in 2% salt solution for 24 hours, wash and prick with fork	-	Blanch in boiling water containing 0.25% citric acid to soften
Papaya	Peel, cut into rectangular pieces, remove seed & prick	Steep in 2% salt solution for 24 hours	Wash thoroughly	Blanch in boiling water until soft
Petha/ (ashgourd)	Cut lengthwise, remove fluffy portion, peel, cut into pieces of suitable size & prick	Soak in diluted lime water for 24 hours to harden texture	Wash and soak in 2% alum solution for 24 hours	Blanch until tender, in boiling water containing little KMS.
Ginger	Scrape off peel with peeler from tender ginger, cut into thin slices	-	-	Boil for an hour with 0.5% citric acid, prick and wash
Citrus peel	Remove the rags from thick rind of orange, citron, pummelo, lime, lemon peel	Dip in 2% hot sodium bicarbonate solution for 30 minutes then wash and prick	-	Blanch in boiling water until tender and to remove bitterness

- Blanch the fruits and place in alternate layers of fruit and sugar.
- Fruits can be dipped directly into syrup without blanching.
- The sugar spreaded in the layers on fruits starts to dissolve in juice which comes out of the fruits.
- In case of syrup, the strength of the syrup is increased by 5% on each alternate day up to the TSS of 70^0B and 75^0B respectively for preserve and candy respectively.
- When the fruit pieces of prepared preserve settle at the bottom of the syrup, it indicates the end point.

In case of candy, the process is similar to preserve making except the concentration of sugar is increased till it attains 75^0B TSS.

- The syrup is then drained off and the pieces of fruits are dried in the drier.
- The prepared candy after draining from the syrup can be rolled in powdered sugar and then dried.

- Pack the pieces in pouches or airtight containers/glass jars.

Alternate method for preserve making

1. Cook the fruit pieces in syrup of low sugar contents and gently heat the mass to boil.
2. Continue boiling till the syrup thickens to 68^0B.
3. Cool the preserve after boiling.
4. Fill hot into clean and pre-sterilized bottles by using freshly prepared sugar syrup.
5. Seal the bottles and store in a cool and dry place.

FPO specifications for preserve and candies

Fruit contents	Not less than 45%
Total soluble solids	Not less than 68% (w/w) for preserve and not less than 75% in candies
Synthetic sweetening agents	Not permitted
Fermentation test	Negative
Organoleptic test	Retain flavour of original fruit and free from burnt or other objectionable flavour
Crystallization	Absent

Ex. No. 25 **Date :**

PREPARATION OF SAUCES

Aim: To conduct practical on preparation of sauce from different fruits.

Theory: Sauces are of thinner consistency as compared to ketchups and contain TSS not less than 15oBrix. Pumpkin, tomato, apple, papaya and plum pulps etc are used successfully for preparation of sauces. Mixed vegetable sauce using pumpkin, tomato, chillies, carrots are sold as continental sauces.

Raw material, ingredients and utensils required

1. Fruits like Apple, tomato, papaya, etc are used for making sauce.
2. Stainless steel knives, de-corers, ladle and utensils for cooking and mixing, glass bottles, sterilization tank, Bhatti/LPG stove etc.
3. The recipe (for 1kg fruit pulp) for preparation of sauce from different fruits is given in.

Recipe for preparation of sauce from different fruits

Ingredients	**Tomato**	**Apple**	**Plum**	**Papaya**	**Apricot+ Tomato 1:1**
Fruit pulp, kg	1	1	1	1	1
Sugar, g	75	50	150	50	55
Salt, g	10	10	20	14	10
Cardamom, Red chillies, g (each)	5	15	10	5	10
Ginger chopped, g	10	100	25	10	
Onion chopped, g	50	200	50	50	100
Garlic chopped, g	5	50	10	5	20
Vinegar, ml (Acetic acid), ml	5 (2.0)	50 (2.0)	40 (1.6)	50 (2.0)	50 (2.0)
Aniseed powder, cumin, g (each)	10	15	10	10	
Sodium benzoate, ppm	750	750	750	750	750

Procedure for preparation of sauce

1. Wash fruits like pumpkin, apple, tomato etc and cut in to pieces.
2. Heat fruits for 10 minutes in their own juice or by adding little water in stainless steel (SS) pan to softening.
3. Pass heated fruits through pulper to extract pulp and to separate skin and seeds.
4. Add half the quantity of sugar and place the spices in a muslin cloth bag and immerse in the pulp during cooking.
5. Cook till the pulp is reduced to half the original volume.
6. Remove the muslin bag and squeeze into the pulp.

7. Add vinegar, salt and remaining sugar.
8. Heat the sauce for few minutes.
9. Fill the finished product in sterilized glass bottles, crown cork and process at 82^0C for 45 minutes.
10. Store in a cool and dry place.
11. End point in sauce is determined by judging the TSS or place small quantity of sauce in pan, allow to cool, if sauce stays without leaving water, indicates the end point otherwise cook for longer period.

FPO specifications for sauces

Total soluble solids	Not less than 25% (w/w) for tomato sauce Not less than 8% in chilli sauce Not less than 15% in fruit/vegetable sauces
Acidity as acetic acid	Not less than 1% (w/w) for tomato sauce Not less than 1% in chilli sauce Not less than 1.2% in fruit/vegetable sauces
Synthetic colour	Not permitted
Fermentation test	Negative
Organoleptic test	Retain flavour of original fruit and free from burnt or other objectionable flavour

Ex. No. 26 **Date :**

PREPARATION OF FRUIT PICKLES

Aim: To prepare pickle from different fruits.

Theory: The preservation of food in common salt (NaCl) or in vinegar or edible oil with the addition of spices and condiments is known as pickling. It is one of the most ancient /oldest methods for preservation of fruits and vegetables. Salt, vinegar, edible oil or lactic acid act as preservative in pickle making. Several kinds of pickles are sold in the Indian market. Mango pickle ranks first followed by lime, lemon, mushroom, galgal, aonla, jackfruit and karonda pickles.

Brining: For pickling, unripe fruits (like mango) after preparation (peeling, slicing) are mixed with salt or brine for its later use in pickle preparation.

Raw material, ingredients and utensils required

1. Mango, lime, lemon, galgal, aonla, jackfruit, karonda etc pickles are most common.
2. Stainless steel peeling/cutting knives.
3. Utensils for cooking and mixing, ladle, glass jars, diesel or LPG/bhatti etc
4. The recipe (for 1kg fruit) for preparation of pickle from different fruits is given in Table

Recipe for preparation of pickle from different fruits (basis 1 kg prepared fruit)

Ingredients	**Mango in oil**	**Lime in salt**	**Mushroom**	**Aonla in oil**
Salt, g	150	200	100	150
Cardamom, Turmeric, Red chillies, g (each)	30	15	5	10
Clove, No's	8	5	5	5
Vinegar or Acetic acid, ml	-	-	100 (4.0)	-
Aniseed powder, cumin, fenugreek, black pepper, g (each)	25	10	5	30
Mustard oil, ml	250	250	250	250

Procedure for preparation of mango pickle

- Wash the mature green mango fruits.
- Cut into 4 equal pieces length wise (depending upon fruit size) and remove the kernel.
- Dip the mango slices in 2% salt solution to prevent browning.

- Drain off the water and dry the slices in shade for 4-5 hours (Mango slices preserved in brine can also be used).
- Heat the oil, cool and mix spices in a little quantity of oil.
- Mix the fruit slices with spices thoroughly.
- Fill mango slices in glass jars and keep the covered jars in sun for a week.
- Shake the jar at least 2-3 times during drying.
- Press the mango slices to remove the air, add remaining oil to cover the mango slices.
- Store the pickle in cool and dry place at ambient temperature.

FPO specifications for pickles

a) Pickles in vinegar

Drained liquid (vinegar) - not more than one third of total content

Acidity of vinegar as acetic acid - Not less than 2%

Alum - Not permitted

Added colour - Not permitted

Fermentation test – Negative

b) Pickles in brine or in citrus juice

Acidity as citric acid - Not less than 1.2%

Salt - Not less than 12%

Preservatives – Sulphur dioxide - Not more than 100 ppm

Benzoic acid - Not more than 250 ppm

Total ash - Not more than 3%

Acid insoluble ash - Not more than 0.3%

c) Oil pickles

Drained weight - Not more than 60.0%

Preservatives - Sulphur dioxide - Not more than 100 ppm

Benzoic acid - Not more than 250 ppm

Oil - Mustard, ground nut, sesame oil

Salt content - Should not be less than 12%.

Ex. No. 27 **Date :**

PREPARATION OF VEGETABLE PICKLE

Aim: To conduct practical on preservation of pickle from different vegetables.

Theory: Pickles are good appetizers and add to the palatability of a meal. Pickles may be unfermented (mostly Indian pickles) and fermented (western pickles). Salt, vinegar, edible oil or lactic acid act as preservative in pickle making. Mixed vegetable pickle from cauliflower, carrot and turnip is most common. Cucumber and olive pickles are examples of fermented pickles. The process of steeping vegetables/fruits in salt solution is also a common method used for preservation of mango and vegetable slices for longer duration storage for its later use in pickling.

Raw material, ingredients, equipment's and utensils required

1. Stainless steel peeling/cutting knives.
2. Utensils for cooking and mixing, ladle, glass jars, sterilization tank, diesel or LPG bhatti etc
3. Vegetables like cauliflower, red chilli, carrot and mixed vegetable.
4. The recipe (for 1kg material) for different vegetable is given in table.

Recipe for preparation of pickle from different vegetables (basis 1 kg prepared vegetable)

Recipe	Red chilli	Green chilli	Onion	Cauliflower	Mixed* vegetable
Salt, g	100	150	250	150	100
Cardamom, Red chillies, g (each)	15	15	10	15	10
Amchur, g or tamarind	250	200	-	100	-
Jaggery	100	100	-	100	100
Clove, No's	6	6	5	5	5
Vinegar	150	150	100	150	200
Aniseed powder, cumin, fenugreek, black pepper, turmeric g (each)	15	15	10	15	10
Mustard oil, ml	700	400	-	400	450
Sodium benzoate, ppm	250	250	250	250	250

***** Mixed vegetable pickle contains cauliflower + diced carrot + turnip in equal amount. Figures in parenthesis represent Acetic acid

Method for pickle making

1. Drain vegetables from the brine, wash and allow drying in sun light.

2. For fresh vegetable, blanch vegetable slices in boiling water, cool, allow to dry in sun light.
3. In the pan, fry spices till brown.
4. Mix the prepared vegetables to the spice mixture and heat for 1-2 minutes.
5. Add vinegar or acetic acid and fill into glass jars.
6. Keep in sun for 5-6 days.
7. Add remaining mustard oil and sodium benzoate.
8. Store in cool dry place.

FPO specifications for pickles in brine

Acidity as citric acid	Not less than 1.2%
Salt	Not less than 12%
Preservatives	Sulphur dioxide - Not more than 100 ppm
	Benzoic acid - Not more than 250 ppm
Total ash	Not more than 3%
Acid insoluble ash	Not more than 0.3%

Ex. No. 28 **Date :**

PREPARATION OF DEHYDRATION OF FRUITS

Aim: To conduct practical on drying of fruits

Theory: Drying generally refers to the method of removal of moisture from the food under natural condition such as sunlight and wind for example open sun drying, shade drying etc. Whereas, dehydration refers to a process of removal of moisture by application of artificial heat under controlled conditions of temperatures humidity and air flow. It also represents drying of agricultural commodity to dry state. For drying, single thin layer of fruit and vegetables, either whole or sliced after primary pretreatments is spread on the trays which are then placed inside the dehydrator or in the open sun for drying. In the dehydrator initial temperature is generally kept at 43^{o}C which is then gradually increased to 66-71^{o}C for fruits.

Raw material, ingredients and utensils required

1. Fruits like mango, grapes, papaya, apple, apricot, date, aonla and fig etc.
2. Stainless steel knives, utensils for blanching and dipping in KMS, dehydrator, drying trays , solar drier, sulpher fumigation chamber.

Procedure for drying: Drying generally involves three stages: pre-drying treatments or pre-treatments, drying and post drying handling, packaging and storage.

Pre- drying treatments

1. Select mature and firm fruits for drying.

2. Sort, wash and peel (where required),

3. Follow schedule for preparation as given in Table

4. Slice apple and Papaya into thin slices.

5. Cut small bunches of grapes along with rachis.

6. Blanching: Fruits like grapes, plum and apricot are dipped in boiling 0.5% NaOH solution for 7-10 seconds followed by cooling to remove the bloom (waxy layer from grapes and plum) or to remove pubescence (hairy growth from apricots) which otherwise interfere in moisture removal.

7. Sulphuring: The sulphuring is done in sulphur fumigation box which is airtight wooden box of 90×60×90 cm size in which the trays are arranged to place the fruit for sulphuring. Generally 3g sulphur for each kg of prepared fruits and is burnt inside the chamber. Sulphur fumigation is carried out for 45-60 minutes to allow the fumes of sulphur dioxide to be absorbed by the commodity. OR

8. Sulphiting: Place the prepared fruits/ in a solution of potassium meta-bisulphite (1-2% KMS) and keep for 30-45 minutes. After the treatment, the fruits are drained and are placed on the trays for drying.

Schedule for drying and dehydration of fruits (preparation and pretreatments)

Fruits	Preparation/ pretreatments	Sulphuring/ sulphiting time	Drying temperature (^{0}C)
Apple	Wash, peel, core, trim and cut into 3-5mm thick slices	30 minutes (1-2% KMS)	60-71 for 6-7 hours or sun dry
Apricot	Dip in 0.5% boiling caustic soda solution for 7-10 seconds and rinse	1 hour (3g sulphur/ kg fruits)	57-68 for 10-12 hours or sun dry
Aonla	Wash, grate or cut into halves, destone	Salt treatment @ 40g/kg fruits	Sun dry
Banana	Wash, peel, cut lengthwise/round shape 12 mm thick	30 minutes (1-2% KMS)	55-71 for 10-12 hours or sun dry
Date	Wash, dip in boiling 0.5 % caustic soda solution then rinse	-	45-50 or sun dry
Grapes	Dip in boiling 0.5% caustic soda for 7-10 sec and rinse or dip in 1-2%. ethyl oleate solution	1 hour (3g Sulphur/kg fruits)	55-60 or sun dry
Mango	Wash, peel, cut into 12 mm thick slices	2 hours (1-2%KMS)	50-60 or sun dry
Papaya	Wash, peel, cut into 6 mm pieces/slices, remove seed	2 hours 1-2 %KMS)	60-65 or sun dry
Prunes	Wash, use whole fruit or cut into pieces, remove seed, pretreatment for 3-5 seconds with boiling 0.5% caustic soda following by cooling.	1 hour (sulphur 3g/ kg fruit)	55-60 or sun dry

9. Drying: Place the prepared fruits/after sulphuring or sulphiting in thin layers on the trays and keep either in sun light, solar drier or mechanical dehydrator. Allow the drying process to continue till a constant weight loss. Frequently turn the fruits upside down for uniform drying. Mechanical dehydrator takes few hours to dry while sun or solar drier takes longer time for drying. The drying time depends upon temperature used for drying and quantity of material loaded in the drier.

10. Sweating: Keep the dried product in boxes/cloth bag or bins to equalize the moisture contents within the product.

11. Sorting, grading and packing: After moisture equalization for 10-15 days, sort the dried product (remove rachis from grape bunches) and grade on the basis of colour, size, and pack in polythene bags or aluminium laminated bags.

12. Yield of dried products: The yield of dried product generally depends upon the total solid content including TSS of the fresh product. Drying yield of different products vary between 20 25%, grapes, 18-20% apricot, 10-12% apple, 14-20% banana and 3-5% onion etc.

13. Storage: Store the dried products in a cool and dry place.

Osmotic dehydration

1. Place the prepared fruits (apple slices, apricot and plum) in 70oBrix syrup at room temperature for overnight.
2. Drain the fruits and rinse in water to remove the excess syrup from the fruit surface.
3. Place on the drying trays and dry in mechanical drier to a constant weight.
4. After drying, keep in the cloth bags for moisture equalization.
5. Pack in airtight bags and store in cool and dry place.
6. The yield of osmotically dried fruits is more than that of fruits dried without osmosis.

FPO specifications for dried and dehydrated fruits and vegetables

Moisture	Dehydrated fruits- Not more than 20% w/w
	Sun dried fruits- Not more than 24% w/w
Preservatives	Sulphur dioxide: Raisins- Not more than 750 ppm
	Apricots, peaches, pears, apple and other fruits - Not more than 2000 ppm

Ex. No. 29 **Date :**

PREPARATION OF DEHYDRATION OF VEGETABLES

Aim: To perform practical on drying/dehydration of different vegetables.

Theory: Drying refers to the method of removal of moisture content from the food to a level at which the activities of food spoilage and food poisoning micro-organism are inhibited. Therefore, reduction in water activity of the food is the main principal of preservation by drying. In the dehydrator initial temperature is generally kept at 43^{o}C which is then gradually increased to 60-66^{o}C for vegetables. The product shall be prepared from wholesome vegetables free from blight, insect infestation and fungal discoloration. Only edible portion of the vegetables shall be used and it shall be free from stalks, peels, stems, and extraneous matter. The dried/dehydrated vegetable may contain permitted preservative. The finished product shall be of good edible quality and shall reasonably reconstitute to its original shape and quality on boiling for 15 minutes to an hour. The finished product shall be free from visible mould, insect or larvae. Kind of dry vegetable shall be declared on the label. Acid insoluble ash shall not be more than 0.5%.

Raw material, ingredients and utensils required

1. Vegetables like cauliflower, cabbage, spinach, coriander, potato, carrot, radish red chillies, onion, garlic, methi, etc. are most commonly dried.
2. Stainless steel knives, utensils for blanching and dipping in KMS, dehydrator, sulphur fumigation chamber, drying trays, solar drier etc.

Procedure for drying:

Follow the procedure for preparation of vegetables for drying as given in Table which include the steps like

1. Selection of vegetables

2. Sorting, washing, peeling (hand peeling, steam, hot water, lye peeling or abrasive peeling and slicing).

Schedule for preparation of vegetables for drying and dehydration

Vegetables	Preparation/ pretreatments	Treatment before drying	Drying temperature (^{0}C)	Drying yield
Cauliflower	Wash, remove stalk, stems, break flowers florets into pieces of uniform size	Blanch in boiling water for 4-5 minutes, immerse in 1% KMS solution for one hour and drain	55-60^{0}C or sun dry or use solar drier	3-4
Cabbage	Wash, remove stalk, outer leaves and cut into fine	Blanch for 5-6 min., immerse in 0.5% KMS solution for 10	55-60 or sun dry or use	5-7

	shreds	minutes & drain	solar drier	
Beans	Wash, cut into small pieces	Blanch for 3-4 minutes and immerse in 0.5% KMS solution for 10 minutes & drain	55-60 or Sun dry or use solar drier	14-16
Onion	Remove the outer peel and cut into round thin pieces	Dip for 10 minutes in 5% salt solution	60-65 or sun dry or use solar drier	10.0
Green leafy vegetables	Wash, sort, trim off rough stems and stalk, shreds	Blanch for 2-3 minutes in boiling water	60-65 or sun dry or use solar drier	-
Potato	Wash, peel, cut into 10 mm thick slices.	Blanch for 4-5 minutes and immerse in 0.5% KMS	60-65 or sun dry or use solar drier	14.0
Tomato	Wash, cut in to pieces	Blanch for 30-50 seconds, peel and cut into round slices 10 mm thick	60-65 or sun dry or use solar drier	3-4
Carrots	Scrap peel, cut stalk and tip cut 0.5cm thick slices	Blanch in boiling common salt solution (2-4%) for 2-4 minutes	68-74 or sun dry	5-6
Bitter gourd	Scrap peel of bitter gourd, cut 0.6 cm thick slices	Blanch in boiling water for 7-8 minutes	66-71 or sun or solar drier	6-8
Ladies finger	Use whole, halves or discs	Blanch in boiling water for 4-8 minutes	63-68	8-10

3. Blanching: Blanching of vegetables is carried out to inactivate enzymes. The vegetables are kept in boiling water or under steam for a pre-determined period followed by immediate cooling.

4. Use either sulphuring or sulphiting for treating vegetables with sulpher dioxide before drying.

a) Sulphuring: The sulphuring is done in sulphur fumigation box which is airtight wooden box of 90×60×90 cm size in which the trays are arranged to place the prepared vegetable for sulphuring. Generally 3g sulphur for each kg of prepared vegetables is burnt inside the chamber. Sulphur fumigation is carried out for 45-60 minutes to allow the fumes of sulphur dioxide to be absorbed by the commodity.

b) Sulphiting: Place the prepared vegetables in a solution of potassium meta-bisulphite (0.5-2% KMS) and keep for 30-45 minutes.

5. Drying: Place the treated vegetables in thin layers on the trays and keep either in sun light, solar drier or in mechanical dehydrator. Allow the drying process to continue till a constant weight loss. Turn the material frequently on the trays to achieve uniform drying. Drying time depends upon the tray load and drying temperature.

6. Sweating:-Keep the dried product in cloth bags for 10-15 days for moisture equalization. Pack the sorted and graded product in air tight containers.

7. Yield of dried products: The yield of dried product generally depends upon the total solid content of the fresh product. Percent drying yield for some vegetables is given in Table.

8. Storage: Store the dried products in a cool and dry place.

FPO specifications

* Preservative – Sulphur dioxide - Not more than 2000 ppm
* Ash – Acid insoluble ash - Not more than 0.5%
* Rehydration ratio - Reconstitute to original shape and quality by boiling for 15- 60 minutes
* The dried product shall be free from visible mould, insect or larvae.

Ex. No. 30 **Date :**

PREPARATION OF VALUE-ADDED PRODUCT FROM TOMATO

Aim: To prepare products from tomato fruits.

Theory: Commercial products from tomatoes include juice, puree and paste. Processing of tomato is now practiced from home scale level to a large scale enterprise. As a semi finished product, tomato puree is prepared on a small scale while at large scale tomato paste has gained commercial significance. Both puree and paste are used for preparation of different finished products like ketchup, juice, soup etc. The method for preparation of these products are well standardized, however, some modification with respect to recipes are made in the processing plants owing to variation in the quality of the raw material. The method for preparation and recipe of different tomato products are as under:-

Raw material, ingredients and utensils required

1. Tomatoes.
2. Stainless steel knives, utensils, juicer, pulper, sterilization tank, glass bottles, corking machine, crown corks, muslin cloth, boiler/gas bhatti, etc.

Procedure for preparation of different products

A. Tomato juice/pulp

Tomato juice is the un-concentrated product consisting of the liquid with a substantial portion of the pulp, expressed from ripe tomatoes with or without the application of heat and addition of salt. The juice should be deep red in colour with a characteristic taste and flavor. The juice shall have about 0.4% acidity expressed as citric acid. Cane sugar (1%) is added to further improve the taste and flavor of the finished product.

Method for preparation of tomato juice

1. Tomatoes should be washed in plenty of running water. Rotary washers or trough washers fitted with moving conveyer belt are generally employed commercially.
2. Tomatoes, after trimming are cut into pieces for extraction of pulp through the fruit grater. Tomato pulp can be extracted either by passing through the pulper after crushing without heating (cold pulping) or after boiling the crushed or whole tomatoes till softening followed by extraction of pulp in a pulper (Hot pulping).
3. Tomato juice/pulp is extracted either by passing the crushed tomatoes through a continuous spiral press.

4. After extraction, edible common salt (0.4-0.6 %) and sugar (1%) are added to the extracted pulp /juice to improve the taste and flavour of the finished product.
5. The finished juice is then heated to 82-88^{0}C and filled hot in pre-sterilized glass bottles. The bottles are then sealed using crown corks and then sterilized in boiling water (100^0 C) for about 25-30 minutes.
6. After sterilization, the bottles are cooled and stored in a cool dry place. Glass bottles are allowed to air cool.

B. Tomato puree

Tomato puree is prepared from tomato pulp without skin and seeds, with or without salt addition after evaporation/concentration of the juice or pulp to desired total soluble solids.

Method for preparation of tomato puree

1. The preparation of tomato puree involves grating/crushing, heating to soften the tissue and straining of heated mass through a pulper finisher.
2. Tomato pulp is prepared from ripened tomatoes is concentrated either by using open cooking method or cooking by using vacuum pan or by using steam jacketed kettle.
3. Boiling should be done at much lower temperature (71^{0}C) to retain the original red colour, flavour with natural vitamin C.
4. The juice is sterilized and packaged in pre-sterilized glass bottles.
5. The bottles are crown corked and processed in boiling water for 25-30 minutes.
6. Tomato puree can also be preserved by adding sodium benzoate (250 ppm benzoic acid).

C. Tomato paste

Method for preparation of tomato paste

Tomato pulp or juice is concentrated to 14-15% soluble solids in open pans followed by concentration in vacuum pans and packing in pre-sterilized bottles while still hot. In large scale processing units, the tomato paste is manufactured by using vacuum evaporators and finally packed either in glass bottles or in bulk aseptic packages. The tomato paste is utilized for manufacture of deferent tomato products like ketchup, soup etc.

FPO specifications

Product	FPO Specification
Tomato juice	• It shall be free from pieces of skin, seeds, coarse tissue and extraneous matter. • The minimum total soluble solids free of salt shall be 5 % (w/w).

	• Shall have good flavour of tomato and be free from burnt or any other objectionable flavour. • The mould count shall not exceed 30 % of the field examined • Harmful poisonous metals in tomato juice shall not be more than 1.0 ppm (lead) 100 ppm (copper on the dried tomato solids basis). 2.0 ppm (arsenic), 250 ppm (tin) and 19.0 ppm (zinc).
Tomato Puree	• It shall contain minimum of 9 % solids excluding salt. • The percentage of TSS required to be declared on the level of the product. • Shall have good flavour of tomato and be free from burnt or any other objectionable flavour. • Mould count should not be excess of 60% of field count
Tomato Paste	• Properly prepared and strained tomatoes shall be free from skin and seeds. • The finished products shall have good flavour characteristics of the tomato and be free from any other objectionable flavour. • It shows no sign of fermentation, when incubated at 37^0C for seven days. • The mould count in the finished product shall not exceed 60% of field examined. • It shall contain minimum of 25 % solids excluding salt. **Depending on the degree of concentration, tomato paste can be grouped as:** • Light tomato paste containing 25-29% of salt free tomatoes. • Medium tomato paste containing 29-33% of salt free tomatoes. • Heavy tomato paste containing not less than 33% of salt free tomatoes.

D. Tomato ketchup:

Tomato ketchup is the commercial product made either from fresh tomato by converting them into juice/pulp or by using tomato puree or tomato paste. It is made by concentrating tomato juice or pulp without seeds and skin. Spices, salt, sugar, vinegar, onion, garlic etc are added to the extent that the ketchup contains not less than 12% tomato solids and minimum of 25 % total soluble solids (w/w). The juice or puree prepared earlier can be used for preparation of tomato ketchup.

Method for preparation of tomato ketchup

The tomato juice is concentrated with spices, salt, sugar etc. About 1/3 of the sugar is added initially at the time of commencing the boiling and the balance is added a little before the ketchup is ready. The sugar added initially helps to intensify and fix the red tomato color. The total sugar, if added initially adversely affects the colour of the ketchup. Salt is added towards the end of boiling, as otherwise, it bleaches the tomato colour. Vinegar should be added when the ketchup has thickened sufficiently, so that the acid does not volatize away. Tomato ketchup generally contains 1.35- 1.5% acid. 0.1-0.2% can be added as a thickening agent. The tomato ketchup is generally concentrated to 25-30% solids. The ketchup is filled hot (88^0C) into pre-

sterilized glass bottles, crown corked and processed for 30 minutes and cooled at room temperature.

E. Tomato soup:

Tomato soup is a fairly popular product now a day. It can be prepared either from pulp or tomato juice. Butter or cream, spices, starch etc. are used for preparation of soup. These are added in different proportions on the basis of desired taste.

Method for preparation of soup: - The juice is boiled in pans for concentration. Add spices in a cloth bag as in case of tomato ketchup, while it is being concentrated. In the mean time arrowroot and butter with small amount of juice are mixed to form smooth paste and added to the whole lot. Boiling is continued to the desired consistency by stirring it continuously. At the end, sugar and salt are added and mixture is boiled for about 2 minutes to dissolve them. The soup is then filled into the cans and closed. The soup is filled hot (88^0C) into cans and is processed at 100-110^0C for 20-45 minutes depending on the size of cans and cooled quickly after processing.

F. Tomato powder:

The tomato juice is converted into a free flowing, highly hygroscopic powder by using different drying methods. Sometimes the natural tomato flavour in powder form is incorporated to compensate any loss of flavour to yield full strength juice powder.

Method for drying of tomato juice: Juice can be converted to powder by using different methods like spray drying, roller drying and foam mat drying. The use of conventional spray driers had not proved successful in producing a free flowing tomato powder due to thermoplastic effects. Powder produced by roller drying also suffers from the thermoplastic and hygroscopic effect and such products are inclined to be flaky in structure and difficult to reconstitute properly, due to glassy surface. Foam mat drying has also been used for producing tomato powders. It is becoming almost a standard practice to pack tomato powder in heat sealed plastic laminated or double plastic bags.

G. Tomato cocktail:

The tomato cocktail contains tomato juice to which common salt, vinegar, Worcestershire sauce, lemon or lime juice etc. are added in different proportions to suit the palate. It is prepared just before use or sometimes also served from the stock.

Method for preparation of cocktail: Boil the tomato juice with the spices loosely tied in cloth bag for about 20 minutes in a covered vessel. Then add lime juice, vinegar and common salt.

After mixing all the ingredients the cocktail is ready, it is filled hot at the temperature of 82-88^{0}C in pre-sterilized bottles. The bottles are closed and kept immersed in boiling water for 30 minutes and cooled.

FPO specifications:

Product	FPO Specification
Tomato juice	• It shall be free from pieces of skin, seeds, coarse tissue and extraneous matter. • The minimum total soluble solids free of salt shall be 5 % (w/w). • Shall have good flavour of tomato and be free from burnt or any other objectionable flavour. • The mould count shall not exceed 30 % of the field examined • Harmful poisonous metals in tomato juice shall not be more than 1.0 ppm (lead) 100 ppm (copper in dried tomato solids), 2 ppm (arsenic), 250 ppm (tin) and 19 ppm (zinc).
Tomato ketchup/ sauce	• The finished products shall have good flavour characteristics of the tomato and free from any other objectionable flavour. • It shows no sign of fermentation, when incubated at 37 ^{0}C for seven days. • The mould count in the finished product shall not exceed 40% of the field examined. • It shall contain minimum of 25 % solids excluding salt. • Minimum acidity should be 1% as acetic acid

Ex. No. 31 **Date :**

FREEZING OF FRUITS

Aim: To conduct practical on freezing of fruits.

Theory: Freezing is a method of preservation in which the food temperature is reduced below freezing point and a proportion of water changes in to ice-crystals. Immobilisation of water to ice and the resulting concentration of dissolved solutes in unfrozen water cause lowering of water activity in the food. Thus, reduction in water activity and use of low temperature coupled with some pre-treatments is the basis for food preservation by freezing. The method for freezing of fruits depends upon the intended use. Generally, fruits after preliminary treatments are packed in sugar syrup and frozen in freezer. The fruits are frozen to an internal temperature of -18^{o}C or lower and kept at -18^{o}C or lower throughout transport and storage.

Raw material, ingredients and utensils required

1. Fruits like pineapple, mango, guava, orange segments, peaches, strawberries, and cherries etc.
2. Stainless steel knives, peelers, blanchers, heating equipment, Freezer, utensils, packages, sugar, citric acid, ascorbic acid etc.

Procedure for freezing of fruits

Pre-process handling

1. Follow different steps for preparation of fruits for freezing
2. Blanching: Blanching of fruits is carried out to inactivate enzymes. The prepared fruits are kept in boiling water or under steam to pre-determined period followed by immediate cooling.
3. Addition of sugar syrup (syrup pack, sugar pack, sugar replacement and unsweetened pack).

a) Syrup pack: Use 40 percent sugar syrup for most fruits for freezing. For mild flavoured fruits, use lighter syrup to prevent masking of flavour while for sour fruits use heavier syrup.

Process variables for freezing of different fruits

Fruit	Preparation	Type of Pack followed by freezing
Apples	Wash, peel, slice and immerse in solution containing citric acid/salt/ ascorbic acid to check browning.	Pack in 30-40% syrup containing 0.02% ascorbic acid.
Apricots	Wash, halve, remove pit, peel and slice if desired. If apricots are not peeled, heat in boiling water for half minute, cool and drain.	Pack in 40% syrup containing 0.02% ascorbic acid.

Avocados	Peel soft and ripe avocados. Cut in half, remove pit and mash pulp (puree).	Add 0.05% ascorbic acid to puree. Package in recipe-size amounts.
Berries	Select firm, fully ripe berries. Sort, wash/ and drain.	Use 30% syrup or dry unsweetened pack, dry sugar pack or tray pack.
Cherries (sour or sweet)	Select well-coloured, tree-ripened cherries. Sort and wash thoroughly.	Pack in 30-40% syrup or in dry sugar.
Citrus fruits	Select firm fruit, free of soft spots. Wash and peel, use segments.	Pack in 40% syrup or in fruit juice. Use 0.02% ascorbic acid in syrup.
Grapes	Select firm, ripe grapes. Wash and remove stems. Slice or use whole.	Pack in 20% syrup or pack without sugar. Use dry pack for halved grapes and tray pack for whole grapes.
Melons (cantaloupe, watermelon)	Select firm-fleshed, well-coloured, ripe melons. Wash rind well. Slice or cut into chunks.	Pack in 30% syrup or pack dry using no sugar. Freeze in recipe-size containers.

b) Sugar packs: Sprinkle sugar over the fruits or fruit slices and gently agitate the container to allow drying out the juice and dissolve the sugar. This sugar pack is generally used for soft sliced fruits such as peaches, strawberries, plums, and cherries, by using sufficient syrup to cover the fruit. Some whole fruits may also be coated with sugar prior to freezing.

c) Tray packs: Unsweetened packs are generally prepared by using tray packs. Spread prepared fruits in single layer on shallow trays and freeze promptly in freezer bags. In tray packs, the fruit sections remain loose without clumping together, which offers the advantage of using frozen fruit piece by piece.

d) Sugar replacement packs: Use artificial sweeteners like saccharine, sorbitol instead of sugar in the form of sugar substitutes. In sugar replacement packs, the sweet taste of sugar is replaced by using artificial sweeteners. Fruits frozen with sugar substitutes will freeze harder and thaw more slowly than fruits preserved with sugar.

Freezing: Carry out freezing of fruits either in chest freezer (-20^{o}C to -30^{o}C), air blast freezer (-18^{0}C to -40^{0}C) or in tunnel freezer.

Packaging: Packaging of frozen fruits is done to exclude air from the fruit tissue. Replacement of oxygen with sugar solution or inert gas or use of vacuum and oxygen-impermeable films is used for packaging frozen fruits. Plastic bags, plastic pots, paper bags and cans (with or without oxygen removal) are common packages. As most foods expand on freezing upto 10% of their volume, the package in which food is frozen should be strong and flexible.

Storage: Store the frozen products in a cool and dry place (in refrigerator).

Ex. No. 32 **Date :**

FREEZING OF VEGETABLES

Aim: To conduct practical on freezing of vegetables

Theory: Freezing is often considered the simplest and most natural way of preservation for vegetables. Frozen vegetables and potatoes form a significant proportion of the market in terms of frozen food consumption. The quality of frozen vegetables depends on the quality of fresh products, since freezing does not improve product quality. Pre-process handling, from the time vegetables are picked until ready to eat, is the important factor affecting quality of finished product. Generally, fruits after preliminary treatments are packed in sugar syrup and frozen in freezer.

Raw material, ingredients and utensils required

1. Vegetables like beans, peas, carrot, cauliflower etc. are most commonly frozen.
2. Stainless steel knives, peelers, blanchers, heating equipment, Freezer, utensils, salt, sugar, citric acid, ascorbic acid etc.

Procedure for freezing

1. Selection of raw material: Vegetables at peak flavour and texture are used for freezing. Post-harvest delays in handling vegetables are known to produce deterioration in flavour, texture, colour, and nutrients. Therefore, the delays between harvest and processing should be reduced to retain fresh quality prior to freezing.
2. Follow different steps for preparation of vegetables for freezing (Table)
3. **Blanching:** Blanching of vegetables is carried out to inactivate enzymes. The vegetables are kept in boiling water or under steam to pre-determined period followed by immediate cooling.

Process variables for preparation of vegetables for freezing

Vegetable	Preparation	Blanch time followed by Freezing	
Asparagus	Wash and sort by size. Remove tough ends. Cut stalks into 5-cm lengths.	Water blanch	2 min.
		Steam blanch	3 min.
Beans	Wash and trim the ends. Cut to desired size pieces.	Water blanch	3 min. (whole), 2min. (cut)
		Steam blanch	4 min. (whole), 3min. (cut)
Beets	Wash and remove the tops leaving 2.5 cm of stem and root.	Cook for 25-30 min. until tender. Cool promptly, peel, trim. Cut into slices or cubes and pack.	
Broccoli	Wash and cut to desired size pieces.	Water blanch	3 min.
		Steam blanch	3 min.

Cabbage	Wash and cut into wedges	Water blanch	3 min.
		Steam blanch	4 min.
Carrots	Wash, peel and trim. Cut to desired size.	Water blanch	5 min.
Cauliflower	Discard leaves, stem and wash. Break into florets	Water blanch	5 min. (whole)
		Steam blanch	7 min. (whole)
Corn	Remove husks, trim ends and wash	Water blanch	5 min.
		Steam blanch	7 min.
Herbs	Washing and cut the roots	No heat treatment is needed.	
Mushrooms	Wipe mushrooms with paper towel Sort, trim and cut large sized mushrooms	Frozen without heat treatment	
Peas	Depodding/shelling of peas	Water blanch	1-1/2 min.
		Steam blanch	1-1/2 min.
Potatoes	Peel, cut or grate as desired	Water blanch	5 min. (Whole), 2-3 min. (pieces)

Cooling: Cooling vegetables by cold water, air blasting or ice will often reduce the rate of post-harvest losses sufficiently, providing extra hours of high-quality retention for transporting raw material to considerable distances from the field to the processing plant.

Freezing: Carry out freezing either in chest freezer (-20^{o}C to -30^{o}C), air blast freezer (-18^{0}C to -40^{0}C) or in tunnel freezer. The temperature regime covering the freezing process, the cold-store temperatures (-18°C), distribution temperatures (-15°C) and retail (-12°C) are generally recommended.

Packaging: Packaging of frozen vegetables is done to exclude air from the fruit tissue. Replacement of oxygen with brine or use of vacuum and oxygen-impermeable films is used for packaging frozen vegetables. Plastic bags, paper bags and cans (with or without oxygen removal) are common packages.

Storage: Store the frozen products in a cool and dry place (in refrigerator).

Ex. No. 33 **Date :**

VISIT TO COMMERCIAL SPICES AND PLANTATION CROP PROCESSING UNIT

Ex. No. 34 **Date :**

VISIT TO COMMERCIAL FRUIT AND VEGETABLE PROCESSING UNIT