TEACHING OF SCIENCE AND TECHNOLOGY IN RURAL AREAS

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Science and Technology of Food Storage and Preservation

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INTRODUCTION

Food is one of the very vital requirements of life. It is the source of energy for all the life processes such as respiration, movement, growth and other metabolisms in our body. Food must contain certain essential nutrients such as carbohydrates which are present in cereals and fruits, proteins which are present in pulses, fat and vitamins which are present abundantly in milk, ghee, eggs, meat, etc. It is very important that our food should not contain materials that would be dangerous to our health. This would result in contaminated food that would cause serious consequences. This contaminated food contains many poisonous substances due to pest attacks and deterioration. When such foods are eaten they result in food poisoning and may even result in death.

Contamination and damage to food materials may occur at any stage in the food-supply system, i.e. from the farm land where it is cultivated till it reaches the consumer. It might occur in the field during cultivation, or after harvest while processing the materials for storage. It might also happen during storage or transportation. So, proper care in handling the food materials must be taken at every stage to preserve their quality and nutritive values.

The present module deals with the various aspects of food storage and preservation practised in rural areas. The areas chosen for the study are Bogadi village, Belavadi village, Yelwal, Hinkal and Kyathamaranahalli, all situated in the Mysore district of the Karnataka state. After a thorough survey in these areas, the following food commodities were chosen for detailed study. These commodities are usually cultivated in these areas. The rural people in these areas also use, sporadically, animal products few of which have been taken for this investigation.

a) Cereals and pulses : Rice, Jowar and Ragi
b) Fruits and vegetables: Banana and Mango
c) Animal Products : Meat, eggs and fish

The module consists of four chapters. Chapter I introduces the terms storage and preservation. A brief history of the storage and preservation practices has been provided. The various factors responsible for the deterioration of food commodities during storage and preservation are discussed and activities suggested to reinforce the roles of the chief factors.

Chapter II provides an analysis of the existing storage and preservation practices with reference to the commodities chosen for the present study. This is followed by an analysis of the basic scientific principles operating in these storage structures. The evaluation items and activities suggested in the chapter should enable the student to understand the basic scientific principles operating in these practices.

An attempt is made in Chapter III to suggest very simple and inexpensive improvisations over the existing practices mentioned in the preceeding chapter. Only such improvisations are suggested which could find easy implementation in our rural areas. These improvisations could be field tested by the students and rural people observations recorded and fed back, so that further improvisations could be investigated.

The module concludes with a brief summary - Chapter IV, which highlights the main points of the study and also provides a few pointers at the new areas of explorations to enrich the rural students and rural people with advancements in science and technology.

When you study this module you will understand the scientific principles on which the existing practices of storage are based. You will appreciate the efforts of science and technology in preventing food *contamination. You will find science as a part of your daily life and not as something to be studied only in the school. You will be able to suggest improvements of existing storage methods to your people.*

CHAPTER - I

WHAT IS FOOD STORAGE AND PRESERVATION?

WHY STORE FOOD?

HOW FOOD GETS CONTAMINATED DURING STORAGE?

RURAL STORAGE PRACTICES

Our country has attained self-sufficiency in food due to the Green Revolution. Despite this, there is an ever increasing need for food in our country because of the staggering growth rate of population. There exists food shortages in certain parts of our country due to various factors such as inadequate rural transport system, lack of organized distribution system and most important of all a substantial wastage due to improper, unscientific storage and preservation techniques. The wastage due to improper storage itself amounts to nearly 15-20% of our total food produce. The national statistics reveal that approximately 30% of the agricultural produce reaches the government storage agency, the Food Corporation of India (FCI). The remaining 70% is stored or sold at the discretion of the individual farmer. A large percentage of this is lost or damaged during storage.

Food storage is a practice at various levels. The house-hold or domestic level, food industries level, retail and whole-sale depots, farmers level and at the government level in the FCI godowns and ware-houses. The basic purpose of all these is to set aside a portion of the food commodity for future use. Food storage has a long history and is, infact, one of the oldest known technology.

The need for storage is very natural and obvious because different crops are grown in different seasons. In other words, though there is always a human need for the various food commodities they cannot be grown at all times. Each crop requires specific climatic requirements such as water, day-night lengths, temperature etc. So the only way to meet the year round human requirement is to store the seasonal produce for use during the seasons when they are not cultivated. This means storing the commodity in a state fit for human consumption. The other purpose of proper storage is to retain their viability as they have to be sown in the next growing season.

Food preservation may be defined as any method of treating food that prolongs the length of time for which its quality, colour, texture, flavour and nutritive values are retained. Food preservation could be seen at two levels: (1) at the domestic level which is a short-term practice and (2) at the commercial level for longer duration.

The earlier methods such as salting, smoking, pickling and fermentation involved very simple materials and techniques for preserving certain items of food stuffs. Gradually, new methods came into use. Some of these include drying, canning and dehydration. Towards the end of nineteenth century the importance of cold-storage was realised resulting in many practices such as chilling, refriegeration and freezing. These are widely used for fruits, vegetables, processed foods, animal produces etc. This has increased the possibilities of transporting the commodities for use at far off places in perfectly good condition.

Besides these, a few natural and chemical preservatives are also employed for food preservation. Some of these are salt, sugar, oil and spices, benzoic acid, Sodium meta-bi-sulphate, acetic acid, citric acid etc.

How Food gets Contaminated (spoilt)in Storage:

Improper storage and preservation techniques lead to deterioration of the food commodities. Spoilt items are a total waste and would not find any use. Uncontrolled and undected deterioration often releases several toxic substances which when consumed causes food-poisoning which at times might even prove fatal.

An understanding of the various factors responsible for bio-deterioration (spoilage) of stored food commodities is very essential to plan proper storage and preservation structures. The major factors operative are mentioned below:

1. <u>Physical Factors:</u> *These are essentially factors of the storage atmosphere in which the food is stored. The most important of these are (a)Temperature and (b)Moisture.*

2. <u>Biological Factors:</u> *These include the inherent qualities of the cultivated crops as well as the numerous organisms that bring about infestation during storage. The important biological factors are:*

(a)Varieties or cultivars of the crop

(b)Infestation by

(i)Micro-organisms .. (a) Bacteria

(b) Fungi (molds)

(ii)Insects

(iii)Rodents

(iv)Birds

3. <u>Chemical factors:</u> *These include the chemical processes going on in the storage commodity and other factors that are 'gifts of science' but which are deterimental to the storage commodity and human health. The important chemical factors are:*

(a) Bio-chemical deterioration

(b)Use of pesticides/insecticides/fungicides/biocides in general.

4. <u>Structural factors:</u> *This includes the structure ofstorage materials, its design and fabrication, and also the type of raw materials used in its making.*

(a)Storage structures

(b)Packaging materials

ANALYSIS OF THE FACTORS

1. ***(a)TEMPERATURE:*** *This is one of the very vital environmental factors. The tropical climatic conditions prevalent in our country are very conducive for the destructive activities and rapid propagation of micro-organisms. The optimal range of temperature for their harmful activities is 20-45°C which is the standard temperature in most parts of our country. Temperature also controls the various biological activities inside the cell such as respiration, transpiration, enzyme activity etc. It also directly controls the other important physical factor, moisture.*

Activity-1

Effect of temperature on storage of fruits

Materials: *Incubator, Ice box, unripe bananas.*

Procedure:

1. *Take one hand (చీప్పు)of unripe banana with atleast 6 fruits.*

2. *Separate individual banana from the banana hand with the stalk. Do not damage the banana.*

3. *Keep a set of 2 bananas in each of the following conditions:*

   (i) at 0 to 5°C in the ice-box
   (ii) at room temperature
   (iii) at 35°C to 40°C in the incubator.

Observe the materials every day and record the observations pertaining to the following points and tabulate them as shown:

Temp	0 - 5°C				Room Temp.				35 - 40°C			
Days	1	2	3	4	1	2	3	4	1	2	3	4
Colour												
Texture(hard/soft)												
Smell												

For thinking

1. Which of the above temperature range helps in quick ripening?

2. Which is the optimal range of temperature for storage?

*(b)**MOISTURE:** Moisture content of a storage commodity always matches with the relative humidity of the surrounding atmosphere. Each commodity has a specific moisture level and inevitably has a critical point, often called the 'safe-limit'. This safe limit is reached by drying the commodity before storage. When the moisture content of the commodity exceeds the safe limits, it becomes congenial for attack by micro-organisms insects etc. This will result in deterioration of the storage commodity.*

Activity-2

Effects of moisture content on storage:

Materials: *Transparent bottles/plastic bags/petridish, jowar grains, water, filter paper.*

Procedure:

I. a)Take a pair of petridish

b)Cut the blotting paper to the size of the inner petridish.

c)Damp it with water. Do not allow excess water.
d)Place few grains on the damp blotter
e)Replace the top half of the petridish
f)Wet the blotting paper at regular intervals to keep it moist.
g)Observe the material periodically at 2 day intervals.

II. Set up a control experiment with a dry petridish.
Tabulate the results as given under. Indicate whether infected(✓) or not (X)

Days	2	4	6	8	10
Control					
Experimental					

III**Conclusion:**

IV. Going further: Repeat the steps involved in the experiment using the following food materials: (i)Rice (ii)Paddy (iii)Ragi (iv)Ripe banana bits (v) Ripe mango bits. Tabulate the observations and arrive at conclusions about the effect of moisture on fungal growth.

For thinking

1. Why cereals and pulses are stored after sun drying?
2. Why infection was observed late in the control set-up?
3. Rice was infected later than Jowar, Why?
4. Why were the fruits infected much earlier to the cereals?

The two physical factors are inter-related each influencing the other in storage.

*2. a.**Varieties and Cultivars:** Persistent plant breeding experiments have resulted in the generation of superior quality crop plants. These are called varieties or cultivars. They are populations of plants below the species level. Though high yielding varieties have been evolved, they have varying storage qualities. In paddy, for example, the finer varieties are more susceptible to insect attacks in storage as compared with the coarser varieties. Similarly, hybrid jowar is more susceptible than naturally evolved jowar.*

*b.**Infestation by Organisms:** Infestation means biological attack on the storage commodity leading to deterioration. The damage caused due to this is quite enormous. Infestations can be brought about by various types of organisms.*

*b.(i)**Micro-organisms:** The term micro-organism refers to living organisms which cannot be seen by the naked eye. They are visible only under high magnifications under a microscope. (Micro=small or tiny).*

*b.(i)(a)**Bacteria:** Bacteria are micro-organisms without a nucleus and they are present in all climates, most rampant in the tropical climate. They bring about a wide range of diseases to crop plants both in the field and during storage. The bacterial activity also releases toxins (poisons) which render the storage commodity unfit for consumption. The most serious instance is the botulinum toxin in canned fruits and vegetables.*

*2.(b)(i)(b)**Moulds (Molds):** Moulds are thallophytes belonging to the group Fungi. Many moulds are parasitic in nature causing very serious diseases to crop plants such as the white rust, wheat rust, anthracnos, smuts etc. Moulds normally thrive well in moist conditions. In fact, the moisture* *level for survival and propagation in some cases is as low as 9%. Moulds are one of the most serious threats to stored products. Their activity liberates several enzymes which destroy the storage commodities. Many moulds also liberate toxins during their metabolic activity. These are called the mycotoxins (mykes = mushroom or fungi : toxin = poison). These mycotoxins, if consumed, cause serious diseases in man which might even result in death.*

Q.1.1 What are fungi?
Q.1.2 What is a parasite?

2.(b)(ii) ***Insects:*** *Insects are a group of invertebrates included in the phylum Arthropoda. There are several types of insects like the beetles, weevils, borers, moths, etc. which infest the grains depleting their quality and nutritive values. They also decompose the grains by their excreta. The grain as a result becomes unfit for usage. Some grain infesting insects also carry on their body harmful micro-organisms such as Salmonella, Streptococcus which cause serious diseases in man. The insects usually eat up the starchy endosperm and reduce the nutritive value.*

Q.1.3 What are invertebrates?
Q.1.4 Why insects are included in Arthropoda?
Q.1.5 What is decomposition?
Q.1.6 Write down a few diseases in man caused by bacteria.
Q.1.7 What is endosperm?
Q.1.8 Where is the endosperm present?

2.(b)(iii) ***Rodents:*** *Rodents are vertebrates included in the class Mammalia. The common infestation rodents are the squirrels, mice, rats and bandicoots. They have teeth and jaws uniquely adapted to gnawing. In India, the most serious rodent pest (causing extensive damage during storage of grains) is the rat. It is estimated that there are about*

5 rats for every person. A pair of rats can give rise to 800 offsprings in a year. Each rat on an average can consume 8-18 g of food grains per day. Apart from stealing the grains, they contaminate the food materials with their faecal matter, urine and hair, which can spread serious diseases. Rats are known to spread about 130 diseases. They gnaw through the walls of storage bins as well.

Q.1.9 What are vertebrates?

Q.1.10 Recall the general characteristics of class Mammalia.

Q.1.11 How is the rat adapted to the gnawing habit?

*2.(b)(iv) **Birds:** Birds are also vertebrates belonging to the class Aves. They eat up a large quantity of the stored food grains. The common house sparrow, myna and the swallows are quite common birds eating the stored grains. Like the rodents they also contaminate the grains with their excreta.*

Q.1.12 What are the general characteristics of Aves?

*3. **Chemical Factors:***

*a) **Biochemical deterioration:** Grains, vegetables and fruits do have an active metabolic life during storage. The assumption that they cease to live once they are harvested is totally wrong. After harvest, during storage, several chemical changes occur in these commodities. Some of these changes are visible, like, discolouration, softening and shrivelling of tissues, kernel damage and sprouting. Some of the invisible chemical reactions are respiration, loss of viability, development or loss of acidity, development of toxicity and total or partial loss of nutritive value.*

*b) **Insecticides/pesticides/fungicides:** These groups of compounds, collectively called the biocides are the result of advancement of human scientific knowledge. At regulated concentrations they are capable of killing the pests like insects, rodents, fungi, etc. But one has to be very careful while using these, because injudicious usage and hasty surface cleaning may leave residual amounts of the biocide on the food commodities which are poisonous and hence dangerous to our health.*

Q.1.3 What precautions would you take while spraying a biocide in your house?

4. ***Structural factors:***

a) ***Storage Structures:*** *This is a factor of vital importance. An ideal storage structure is one which gives protection against micro-organisms, pests, and also effectively controls the environmental factors such as temperature and moisture during storage. The material with which the storage structure is built, its permeability characteristics, non-wetting characteristics contribute a great deal to proper storage. Modern science and technology has given us hi-tech storage materials and practices. But none of these can offer cent per cent protection against deterioration if the commodities are not properly dried and disinfected prior to storage.*

b) ***Packaging materials:*** *This is of importance particularly during the transport of the food commodities. They are particularly important during the transport of fruits, vegetables, animal products, processed foods, etc. The packaging material for chilled and frozen foods must have very low permeability characteristics with regard to water vapour. They are generally light weight and made of non breakable material.*

Q.1.14 What is meant by permeability?

RURAL FOOD STORAGE AND PRESERVATION PRACTICES

There exists different rural storage practices for different food commodities. Cereals and pulses are stored in underground as well as overground storage structures. Fruits and vegetables are not generally stored in large quantities in the villages. They are usually sent to the wholesale market soon after harvest. Mango however, is partially ripened before it is sent to the whole-sale markets.

Meat, fish and poultry products are not stored in the rural areas. In fact, even though the rural population comprises of a large percentage of meat eaters, meat is not consumed frequently. Whenever it is eaten, it is cooked and consumed soon after the animal is slaughtered.

Eggs are however more frequently consumed. They are kept in small baskets or in cardboard trays and used within 3-5 days.

As facilities for cold storage are totally absent in the rural areas, the food is always cooked to very near the actual requirement each time. As a result, left-overs are only minimal and are usually consumed during the next meal.

Methods of preservation of fish such as drying, salting, etc. are practised in the coastal areas where sea fish and other sea animals are available in plenty.

Many simple and improvised techniques for storage and preservation are developed by the CFTRI, Mysore, Indian Grain Storage Institute, Defence Food Research Laboratory, Mysore, etc. Many of these can be easily adapted by the rural people by means of which wastages can be considerably reduced.

CHAPTER - II

EXISTING STORAGE STRUCTURES - THEIR SCIENTIFIC PRINCIPLES RIPENING PROCESS IN FRUITS

EXISTING STORAGE STRUCTURES

The most prevalent method of storage of cereals and pulses in Rural Karnataka include the traditional structures. These are Hagevu (ಹಗೇವು), guli,(ಗುಳಿ), pette (ಪೆಟ್ಟೆ), kanaja (ಕಣಜ), Gonicheela (ಗೋಣಿಚೀಲ), Thombe (ತೊಂಬೆ). Some of these storage structures are underground and others constructed above the ground. They are basically made of straw, wood, bamboo, reeds or cement/clay or masanory structure.

At the household level rice is usually stored in dry air tight containers with pieces of turmeric, garlic, asafoetida in them. Wheat is also stored in drums with dry neem leaves. Turmeric, garlic, asafoetida and neem leaves have insect repellent properties due to their pungent odour and bitterness.

While the staple food grains such as rice and pulses require long term storage methods, fruits and vegetables, by and large, need only short term storage methods lasting for only a few days.

The most popular storage practices for fruits like banana and mango, the subject of the present study are - storing in granite built masonary cellers called Gudanas (ಗುದಾಣ) for bananas and hay packed storage for mangoes (ಅದೆಹಾಕುವುದು).

Hagevu: *(Fig.1)*

This is an underground storage structure. These are prevalent in dry districts of Karnataka, where the water table is very low. Jowar and ragi are stored in these structures.

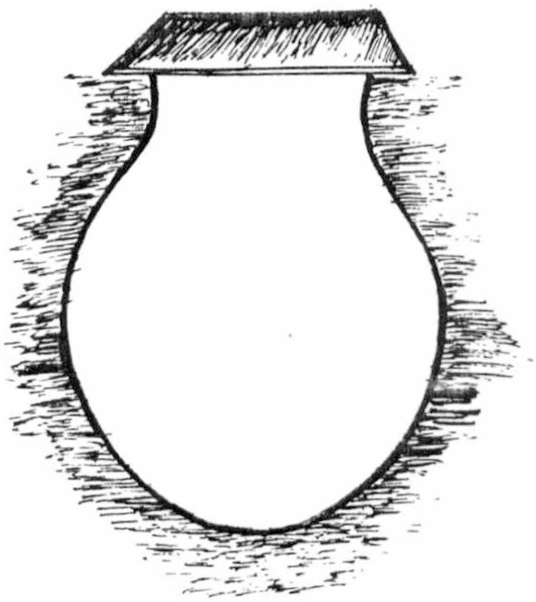


Fig 1 Hagevu

__Construction:__ *Hagevu* *is constructed by digging a pit of required size which may be as deep as 5' - 20' with diameter varying from 5' - 10'. There is an opening at the top just enough for a man to enter. Loading and unloading is done from the same opening. Paddy husk or straw is spread on the floor and inner walls of the structure before loading. The inlet is covered with a slab and in turn plastered with mud.*

Kanaja: *This is one of the most prevalent indoor bulk grain storage structures in Karnataka. They are square or rectangular structures that are above ground. (Fig.2)*

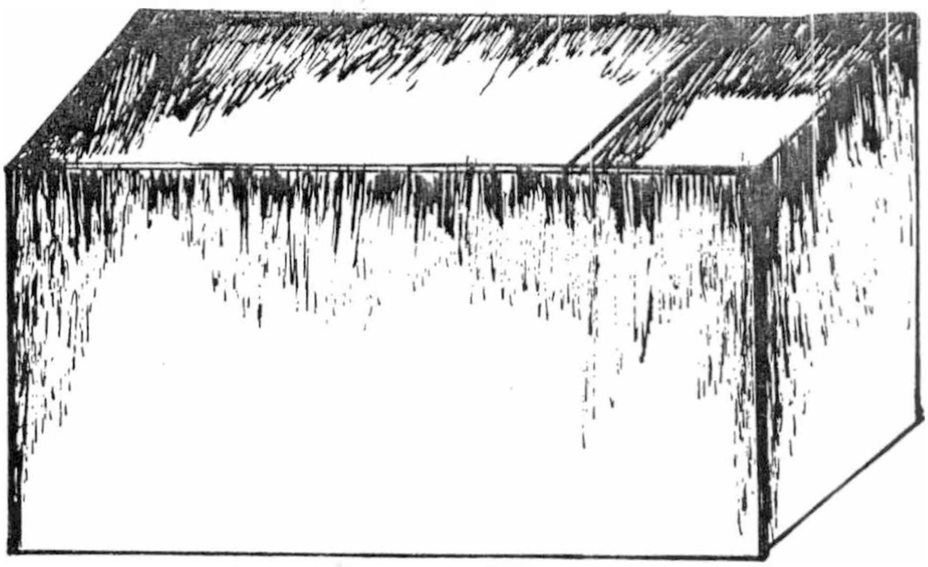


Fig 2 Kanaja

__Construction:__ *The sides are raised to a height of 2' - 4' with locally available materials like stones and mud. The floor of the kanaja is similar to that of the house in which it is constructed. It may be mud flooring, stone slab flooring or cement flooring. The wall is made of bricks, stones or wooden planks. The inlet which is at the top is used for loading and unloading grains. Kanaja may be single or separated into two chambers with a partition wall in between, depending on the requirement.*

__Pette/Thombe:__ *These are indoor structures made out of bamboo splits. There is very little difference between Pette and Thombe. Both are cylindrical in shape. In case of Thombe, the mouth and the bottom are narrower as can be seen from the following diagrams. These structures are plastered with mud or cowdung. Sometimes, pette is* prepared with bamboo mats. Both loading and unloading is carried out from the top. The capacity of these structures depends on the requirement. (Figs.3 & 4)

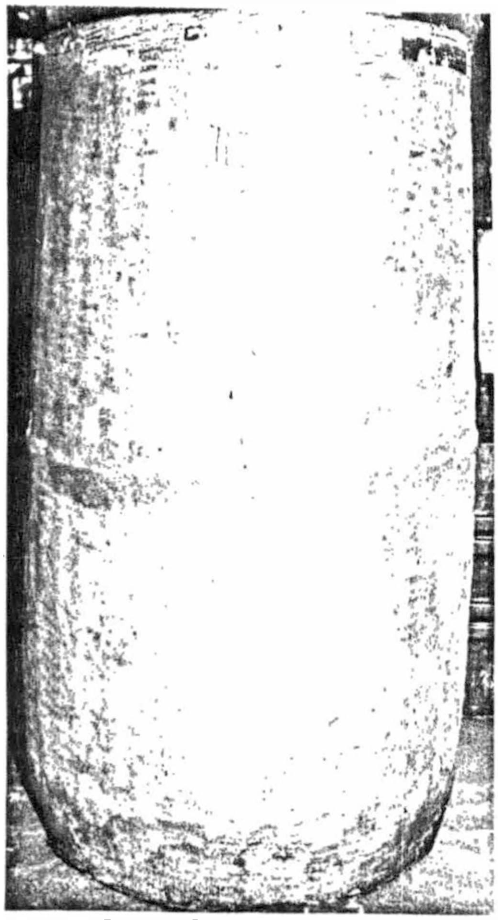


Fig 3 Pette

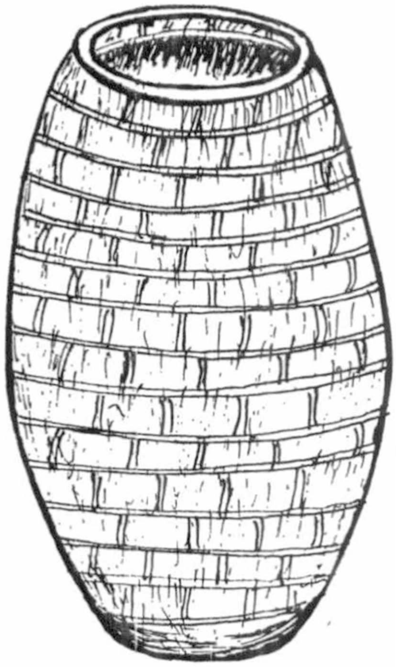


Fig 4 Thombe

Gonicheela (Gunny Bags): These are made from jute fibres. All kinds of pulses and cereals can be stored in these bags. They are usually kept on elevated platforms or on wooden planks, rarely, on floor.

FRUITS AND VEGETABLES:

The terms fruits and vegetables are loosely used to a wide range of edible plant materials mostly consumed raw or processed. Fruits, to most people means edible as picked. They are generally sweet and have pleasant flavours. Vegetables on the other hand are often eaten after cooking and are generally not sweet.

The production of fruits and vegetables is less than the requirement. These products themselves have a rapid ripening phase followed by short storage life. The above two conditions necessitates storage practices which delays the ripening process. Once ripening is complete, gradual death of commodity sets in, making it unsuitable for consumption and also prone to pathological infections. However, there are certain areas in the Karnataka State where production is in excess of local needs. Unfortunately, in many such backward areas, there are poor transport facilities for shipment to the areas of need. In such areas, there is a need for proper storage structure and preservation practices.

Gudana/Guli: *(Figs. 5a and 5b)*

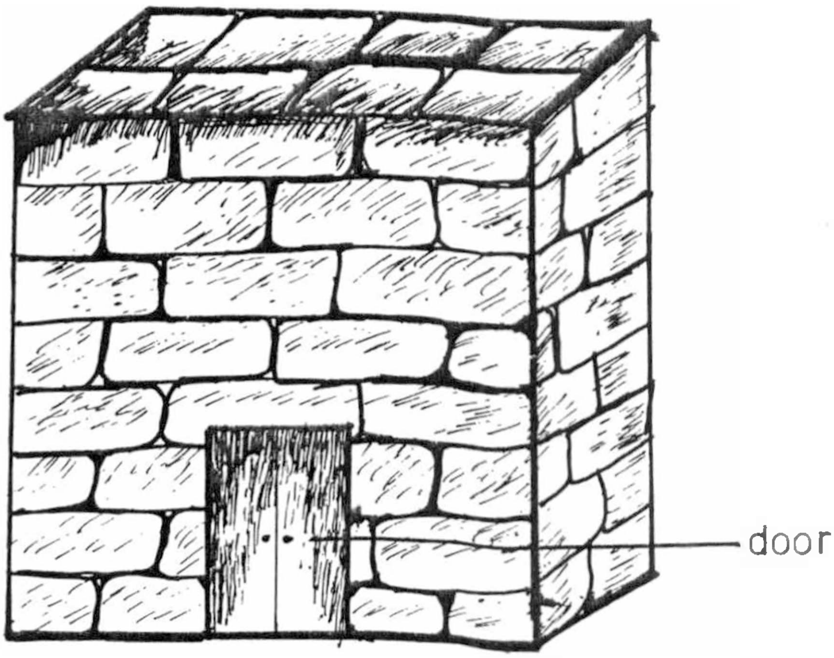


Fig 5a Guli

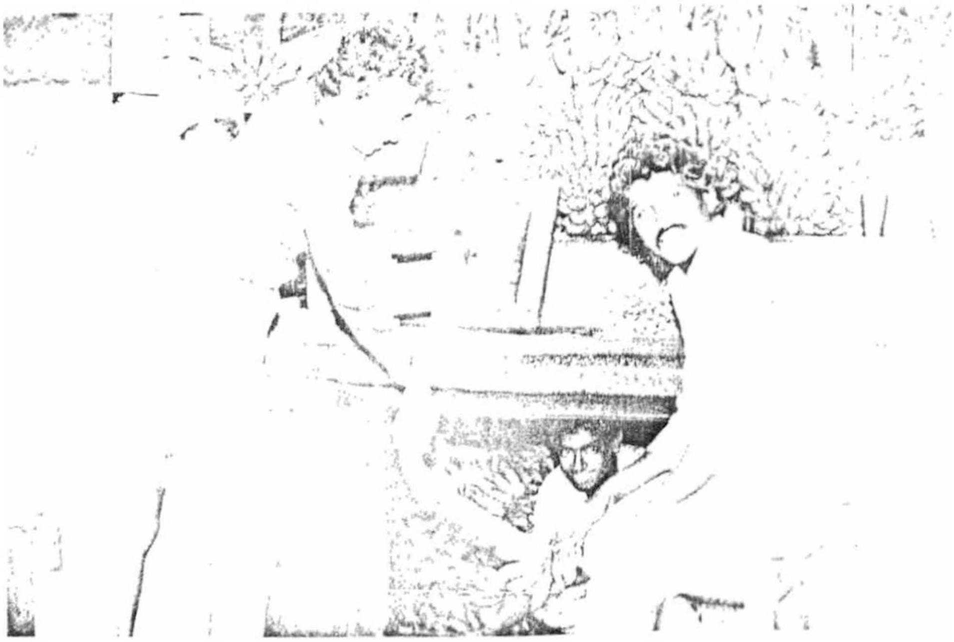


Fig 5b Gudana/Guli

Some of the common methods followed for banana (the subject under study) ~~in major growing areas and in the~~ mandis (wholesale fruit markets) are the age-old traditional practices such as

1. *storage in closed cellers without any ventilation (Fig.5a)*
2. *closed granite built bins (underground and above the ground)*
3. *heaping the bunches (ಗೊನೆ) one above the other after applying slacked lime to the tip of raw fruits. (Fig.5b)*

These structures are generally referred to as Gudanas or Gulis. The dimensions of the structure varies according to the requirements. In a Gudana of 6'x6'x6' about 200 bunches (ಗೊನೆ) are stacked accounting for nearly a total of 4,000 fruits. Usually, the inside of Gudanas are moisture free and disinfected with chemicals just before storing the raw fruits. The process of ripening takes about 8 days after which the commodity is ready for consumption. It is a common practice to hasten the ripening process during storage. This is done by lighting a kerosene stove inside the gudana and allowing it to burn overnight. The gudana is shut air-tight during the night. By the next morning, i.e. 10-14 hours duration the fruits are 90-95% ripe. The bunches are removed from the gudanas and are ready for retail selling.

Ade Hakuvudu (Fig.6)

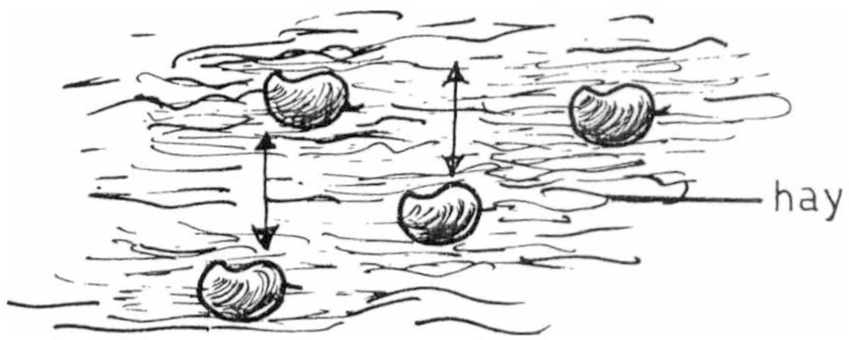


Fig 6 Ade-hakuvudu

Badami, Raspuri and Ginimuti are some of the well known commercial varieties of mango grown in the rural areas of Mysore district. Wild varieties are also available. Superior quality hybrid and more yielding varieties are also under cultivation. Mango is plucked unripe when the rind ~~is still dark green. The fruit is packed~~ in baskets or wooden cases and transported by local means to a nearby area where the storing and ripening are done. Usually the raw fruits are spread on a cushion of straw and the fruits are placed a little away from each other. It is again covered with a layer of straw. Thus the raw fruits are sandwitched between the layers of straw. This process is known in vernacular language as 'Ade hakuvudu'. The fruits are ripe in 2-3 weeks' time and are ready for marketing.

Activity 3:

To show that there is rise in temperature during respiration in storage.

Materials Required: Thermos flask, single hole cork, Thermometer, raw/semi ripe banana.

Procedure:

1. Take the thermos flask.
2. Insert a thermometer through the single-hole cork.
3. Keep raw/semi ripe bananas in the flask. Close the mouth with the cork.
4. Observe the rise in temperature after 3-5 hours.
   Tabulate in the following table and interpret.
5. Repeat the experiment with other food commodities.

Temperature at the start of experiment = °C

Days	Temperature °C
1	
2	
3	
4	
5	

Going Further

Repeat the experiment using paddy, rice and fruits.

For thinking:

Can you mention some reasons for the rise in temperature?

Meat, fish and poultry products are not stored in rural families. They are cooked and consumed immediately after the animal is slaughtered.

Similarly, cooked food is also not stored in the families. They are either fed to the domestic animals or eaten during the next meal.

ANALYSIS OF THE SCIENTIFIC PRINCIPLES OF THE STORAGE STRUCTURES:

It is evident from the above that there are several methods for the storage and preservation of food commodities. Most of these practices suffer from a few setbacks because of lack of a thorough knowledge of the principles in their fabrication and use. This has inevitably led to improper storage resulting in extensive losses due to deterioration. An attempt is made in this chapter to analyse the basic scientific principles involved in the above said storage practices.

Hagevu: *It is a very simple out-door underground storage structure which is in use in the rural areas. The chief scientific principles involved in the construction of Hagevu are :*

1. *It is constructed in places where the water table is low.*

    Q.2.1 What is meant by water table?

    Q.2.2 Why is a Hagevu constructed in a place where the water table is low?

2. *The peripheral walls of the Hagevu are lined with either straw or dried jowar stems so that they form a separating layer between the mud wall and the cavity of the Hagevu.*

    Q.2.3 What could be the role of this internal wall layer?

3. *The floor of the Hagevu has a layer of paddy/ragi husk over which the commodity is stored.*

Q.2.4 What is the need for the layer of paddy or ragi husk?

4. *The Hagevu has limited aeration and is totally dark.*

Q.2.5 How do you think these conditions prevent infestation by insects and other organisms?

5. *The stone slab placed on the narrow opening of the Hagevu is not removed frequently.*

Q.2.6 What is the reason?

6. *It is a common practice to leave the Hagevu open for a day or two before entry into the structure, to take out the commodity. Another precautionary measure before entering the hagevu is to lower a burning candle into it.*

Q.2.7 Analyse the reasons for the above two practices.

Kanaja : *It is an indoor masonary storage structure built above the ground level. The chief scientific principles in the construction of kanaja are :*

1. *The structure is above the ground on a platform and is exclusively damp-proof internally.*

~~*Q.2.8 Why is the interior of kanaja damp-proof?*~~

2. *The materials and the design used in the construction of kanaja renders it rodent proof.*

<u>**Pette/Thombe:**</u> *They are indoor storage structures suitable for small quantity storage. The chief scientific principles involved in their construction are*

1. The interior and exterior of <u>Pette/Thombe</u> are lined with mud/ cowdung/fenugrek paste.

> *Q.2.9 What would happen to the stored commodity without the surface applicants?*

2. The seeds stored in these structures remain viable.

> *Q.2.10 What could be the reason for the above?*

<u>**Gonicheela:**</u>

1. Provides good aeration for the commodities stored and maintains viability.

2. It is easy for transportation and handling.

<u>*THE RIPENING PROCESS IN BANANA:*</u>

In order to increase the shelf life of fruits, the basic understanding of biochemical processes going on inside the fruit is essential.

The production of CO_2 in plant tissues is one of the basic biochemical processes linked with respiration. (Refer Activity 2). It has been reported that fruits with high respiratory rate have relatively short storage life. In other words, in the commodities which respire faster, senesence sets in quickly leading to rapid deterioration. Banana has short storage life ranging from 12-18 days after harvesting. Commodities with low respiratory life has a long storage life. Eg. Apple, Guava, Mango. This enables the transportation of these commodities to far off places. Any process that retards the rate of respiration will increase the shelf life. Soon after harvest the rate of respiration in banana increases. If this is allowed to go on, the fruits ripe quickly, soften and start rotting. So external heat is avoided in the storage of banana and hence prolongs shelf life.

Banana Gudanas/Gulis :

Some of the scientific principles involved in the storage of banana are:

1. *The interior of the cellers are disinfected with chemical spraying before storing the fruit, thus rendering the place sterile for most organisms.*

2. *External source of light is avoided as this would rise the internal temperature of the celler, which in turn hastens ripening process.*

3. *As Gudanas are closed chambers, the CO_2 released from the respiring fruits during ripening is retained in the celler itself.*

4. *Smoke is introduced into the guli thereby increasing the level of CO_2, ethylene and acetylene. These hasten the ripening process and also bring about uniform ripening.*

Q.2.11 *~~Can unripe bananas be stored in open air and light?~~*

Q.2.12 *What would happen to the shelf-life of banana in the above case?*

Ade Hakuvudu:

Dry hay used in mango storage helps in the retention of heat emitted during the process of respiration, (Refer Activity 2) consequent in the ripening process. This helps in uniform ripening and enables pigment formation (carotenoids and anthocyanins) which impart the colour to ripe mangoes.

Raw mangoes are less prone for insect and pathogen attack than the ripe mangoes, because of the aromatic sap (ಸೊನೆ) which acts as a repellant. The only possibility of infection of raw mangoes is due to surface injuries and breakage during picking and transportation.

C H A P T E R - III

IMPROVEMENTS ON EXISTING METHODS

MODERN METHODS OF STORAGE AND PRESERVATION OF FRUITS AND VEGETABLES

IMPROVISATIONS OF EXISTING STORAGE AND PRESERVATION PRACTICES:

The preceeding chapter briefly outlines the existing practices and the scientific principles operating therein. An average small time land tiller builds the storage structures suitable to his requirements by acquiring the knowhow from his fellow farmers and his fore-fathers. He is, however, unaware of the scientific principles underlying these practices. If, he is given a basic understanding of these, it would help him improvise the existing storage practices and render them more efficient. Though there are innumerable modern storage practices involving high technology, cold storage, etc. an average Indian farmer can hardly afford this technology because of its sophistication and exhorbitant cost. It would therefore, be meaningful if the existing practices can be improved upon. Many pioneering agencies have already undertaken this work and have suggested improvements, some of which will be discussed here.

Hagevu: *In this traditional storage structure, the major problem is that of moisture seepage. This results in microbial damage and subsequent deterioration. The following guidelines would help check the moisture seepage. (provided by Indian Grain Storage Institute, Bapatta).*

1. The walls and floor of the underground structure could be made of brick lining with liberal application of liquid coal tar or any other effective moisture - proofing material. This would be superior to the existing structure built in mud and without any moisture *proofing materials. Coal tar is a very suitable material which on drying forms a very firm, non-porous coating around the storage structure making it totally impermeable to water and moisture.*

2. Stone slabs could also be used instead of bricks with proper sealing of joints with cement mortar. Stone slab is a superior material to bricks because bricks being made of clay can absorb moisture from the surrounding areas and are likely to moisten the interior of the storage structure. On the contrary, stone slabs have no water absorbing qualities.

3. Another suggestion given by the Peace Corps is to line the interior of the underground structure with plastic sheet. They also suggest the storing of grain in small quantities in sealed plastic bags, placed inside the plastic lined underground structure.

Kanaja: *As this structure is overground and made of stone slabs it checks moisture entry to a great extent and is also inaccessible to rodent attack. The only possible route for the entry of water or moisture is through the trap-door on top. So precaution must be taken to keep the trap-door far away from water sources such as taps, rain water gulleys, etc.*

Pette: *The practice is to apply a thin coat of cowdung or mud to the interior or exterior of the structure. Researches by CFTRI, Mysore have recommended the coating by fenugrek instead of the above mentioned as it is known to possess better insecticide properties than cowdung and mud. Cowdung has yet another disadvantage. Moistened cowdung is a good substratum for the growth of coprophilous fungi which may indirectly have degradative effects on the storage commodity.*

__Gonicheela (Gunny Bags):__ *(Fig.7)*

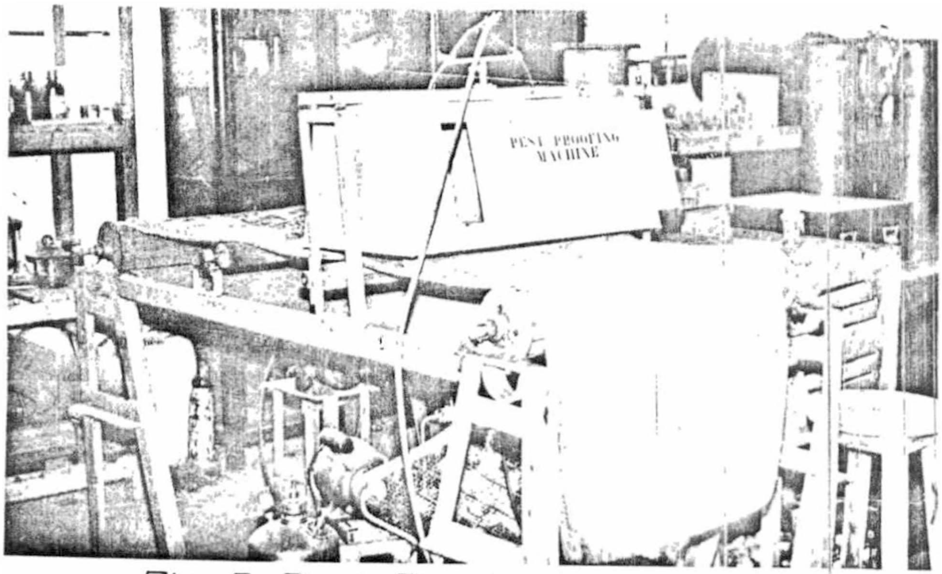


Fig 7 Pest Proofing Machine

It is a practice now-a-days to subject the gunny bags to treatment by specific chemicals before storing any commodity to render it insect and rodent proof. A simple, portable machine for this purpose has been developed at the CFTRI, Mysore. The pest proofing powder/emulsion is sprayed over the gunny bags quickly and evenly. The machine can process about 400 bags in one hour and the cost of pest-proofing is approximately 30p/bag.

__BANANA STORAGE:__

The two improvisations recommended by the CFTRI are a) dipping the entire bunch soon after harvest in a wax-emulsion to which can be added an antifungal agent. (Figs.8(i) and 8(ii)a) The emulsion and the antifungal agent are available at CFTRI, Mysore b) applying antifungal paste to the cut edges of the banana hands (ಚಿಪ್ಪು) drastically cuts down the incidence of fungal infection (Fig.8(ii)b). The cut edges are the most susceptible spots for initial fungal infection.

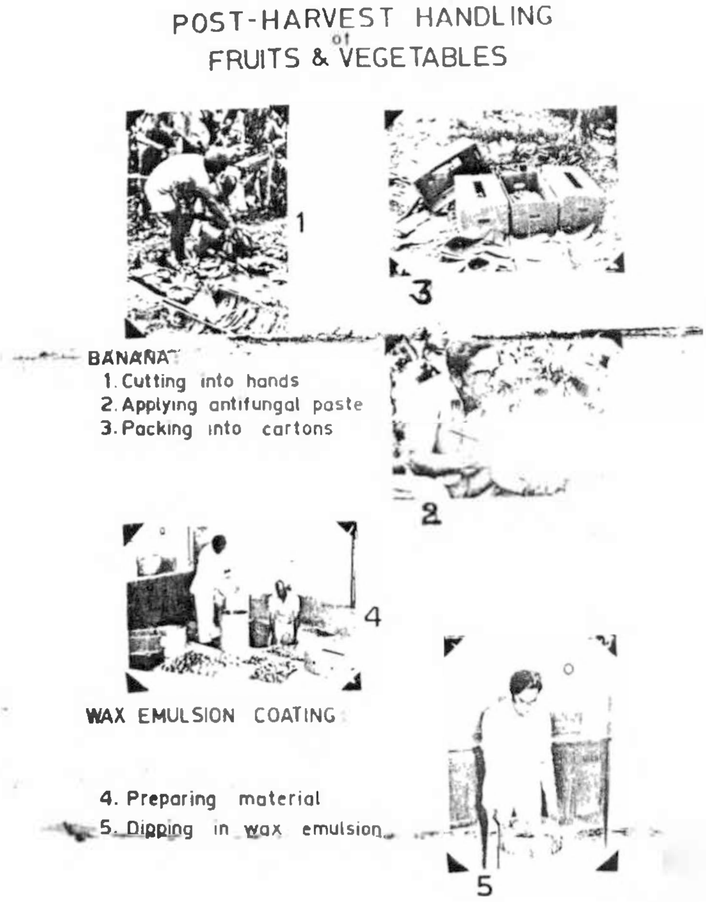
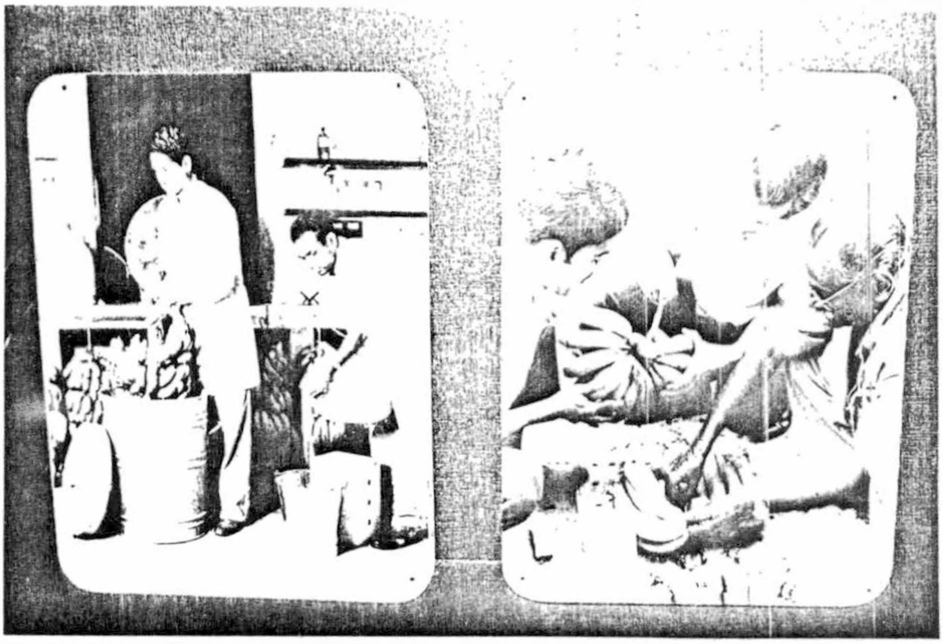


Fig 8(i)



a. Dipping bunches in wax emulsion   b. Applying anti-fungal paste

Fig 8(ii)

The introduction of smoke during storage actually hastens the ripening process. Smoke, besides CO, CO_2 contains ethylene, little amount of acetylene which are known to speed up the ripening process.

Activity 4:

Effect of Ethylene, Carbon dio-oxide in ripening of bananas.

Materials: Cardboard boxes with lids (medium size) - 3 Nos.
Few banana hands, a spirit/kerosene lamp and
calcium hydroxide, beaker.

Procedure:

1. Label the card-board boxes 1,2 & 3.
2. In box 1, keep a banana hand. Close the box and leave it as such . This will be the control experiment.
3. In box 2, keep a banana hand, light a small kerosene lamp. Close the lid. After 3 hours, put off the kerosene lamp and close the lid.
4. Set up box 3 the same way you set up box 1. Keep a beaker with calcium hydroxide.
5. Observe the 3 boxes every day for 3 days and note down your observation.

	Characteristics of the fruit								
	Colour			Texture- hard/soft			Ready to eat		
	1	2	3	1	2	3	1	2	3
Box 1									
Box 2									
Box 3									

For thinking:

1. *Why differences in ripening were noticed in boxes 1, 2 and 3?*
2. *Why was ripening delayed in box 3.*
3. *Why did the fruits ripen faster in box 2?*
4. *Why was ripening slow in box 1?*

In fact, even during the natural process of ripening in the smoke-less storage bins, a little amount of ethylene is released by the metabolic activity inside the fruit. By providing additional C_2H_4 (ethylene) we are actually hastening the ripening process. So, obviously banana ripens quicker in an ethylene supplied storage structure than in one without an external supply of ethylene. The other advantage of smoking is that all the fruits in a bunch are brought to more or less the same level of ripening and the chances of a few hands ripening early to other is overcome.

A new design banana packaging material is shown in Fig.9. This is collapsible and made of corrugated fibre board with openings in it as shown. The openings regulate the CO_2:O_2 levels and enables the maintenance of an ambient temperature for transportation that would retard the ripening process. Packing in these boxes delays the ripening by 6-10 days.

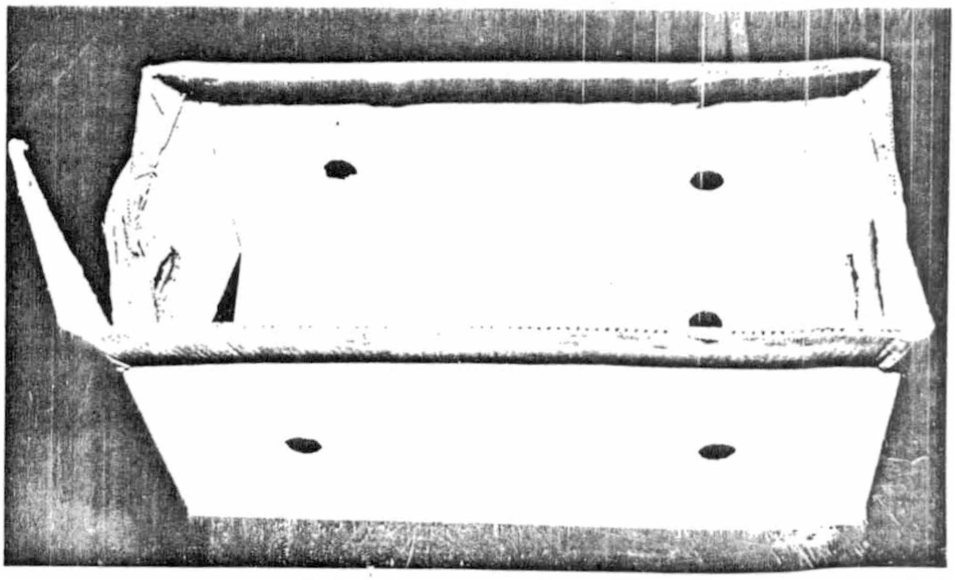


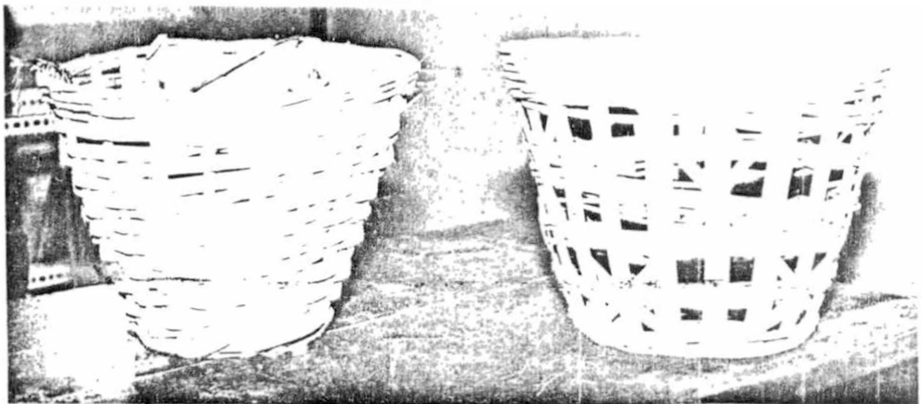
Fig 9 Improvised banana box

MANGO STORAGE:

It is disheartening to note that nearly 30-40% of the harvested mangoes are lost due to fungal infection under the traditional regime of storage and ripening. There are several ways to reduce this wastage. Some of the effective measures are to dip the mangoes (raw) in a wax emulsion strengthened with a fungicide briefly for 3-5 minutes, dried naturally and then packed in hay as outlined in Chapter II. This would prevent fungal and insect attacks at later stages of ripening when the sugar content in the fruit suddenly increases (at about 90% ripening stage), making it highly susceptible for fungal attack. This pre-treatment with emulsion reduces the wastage to as low as 5-6%.

Another simple method is to dip the unripe mango fruits for five minutes, in hot water at 55°C and then pack in hay. This kills the surface fungi and insects and prevents spoilage during ripening. This method is extremely beneficial commercially because it produces uniform ripening and the quality of the fruit is very near the quality of naturally ripened fruit.

A specially fabricated mango basket (Fig.10) designed by the CFTRI, Mysore permits optimal ventilation and the structure, particularly the cross-pieces around the basket affords firmness and rigidity to the basket. This avoids the crushing which is likely to occur in an ordinary basket which would buckle under pressure because of lack of lateral and vertical strengthening.



a. Ordinary b. Improvised

Fig.10 Mango baskets

Activity 5:

Observation of conversion of starch to sugar in ripening.

5.1. Eat a little bit of unripe banana and ripe banana. Record your observation.

	Ripe	Unripe
Taste (sweet/bitter) Texture (soft/hard) Palatability (good/bad)		

5.2 Experiment to test for starch.

Materials Required: *Ripe/unripe banana, pestle and mortar, hot water, laboratory reagents.*

Procedure:

1. *Make an extract of unripe and ripe banana in hot water using the pestle and mortar.*
2. *Take a small quantity of the extract separately in the test tubes and add a few drops of iodine solution. Record your observation.*

	Change in colour
Extract A	
Extract B	

5.3. Repeat the experiment with Benedicts solution (test for sugar).

5.4. Molisch test for the presence of sugar.

Materials Required: Above extracts, naphthol solution (1% naphthol in 70% alcohol) and concentrated H_2SO_4, test tubes.

Procedure

1. Take the aqueous extract of the unripe fruit and shake with a few drops of naphthol solution.
2. Add concentrated H_2SO_4 drop by drop carefully along the sides of the test tube. Observe.
   Violet colouration indicates the presence of sugars.
3. Repeat the test with ripe banana extract. Observe and conclude.

For thinking:

1. Why are ripe bananas sweet but not the raw bananas?
2. Why a ripe banana is negative to starch test?

Activity 6:

Increasing the longivity of eggs.

Materials Required: Two fresh eggs, any vegetable oil - 50 ml. Balance

Procedure:

1. Apply a thin coat of oil on one egg. Keep the other egg as it is.
2. Check the weights of each egg and record in the tabular column given below.
3. Check the weights of the eggs every three days for 15 days and record their weights.
4. Conduct the 'candle test'* after 15 days.

   *Candle Test:** Hold the eggs against a burning candle, observe and record in the tabular column.

	Eggs without oil coat					Eggs with oil coat				
Days	3	6	9	12	15	3	6	9	12	15
Visible-dimly/plainly (yolk)										
Weight of egg (gms)										
Air cell size (small/large)										

Clue: Smaller the air-cell and dimly visible yolk are features of a well preserved egg.

For thinking:

1. *Why was the egg coated with oil preserved better than the other?*
2. *Was the respiratory rate of the egg without oil coat higher than the other or lower? Why?*
3. *Is egg a living object or not? Give two reasons.*

Activity 7:

Storage Structures

Materials Required: *4 small sized pette with lid made from bamboo splits; cow dung, red clay, fenugrek.*

Procedure:

1. *Apply a thin coat of cowdung/red clay/fenugrek separately on three pettes interior/exterior.*
2. *Dry them thoroughly in the sun.*
3. *Store a sizable quantity of cereals in each of them and observe periodically for insect/rodents infestation.*

Design a suitable tabular column and record your observations for a period of 2 months at regular 10 day intervals.

Suggested Parallel Activities:

1. *Field trips to banana and mango storage places and mandi.*
2. *Field trips to nearby villages to observe the storage structures of the local commodities.*
3. *Field trips to the city ware-houses, godowns and FCI godowns to observe storage practices of cereals and pulses.*
4. *Preparation of models of the storage structures.*

MODERN METHODS OF STORAGE AND PRESERVATION:

The traditional storage and preservation techniques for fruits and vegetables are still in practice even today such as the gudanas for bananas and the process of ripening discussed for mango. Though very refined preservation techniques have emerged in the western world, their usage in our country is very limited because of the cost factor. A few of the modern technologies will be briefly discussed here to enable the students to appreciate the advancement in storage technology. The procedures that are discussed below would pertain to fruits and vegetables in general. Some of the important modern methods are

1. *Chilling and refrigerated storage*
2. *Dehydration*
3. *Freezing*
4. *Chemical Preservatives*
5. *Irradiation*

1. Chilling and Refrigerated Storage:

It is one of the widely used methods for short term preservation of fruits and vegetables. Cooling a product retards microbial growth and also biochemical deterioration. The operating principle is very simple. A drop of every 10°C halves the deteriorative rates.

Chilling alone would not be very effective if it is not coupled with modified atmospheric storages such as gas-tight chilled storing where the concentration of respiratory gases is kept at optimal levels (pre-decided). The main application of this technique is to extend the storage life while it is being transported by rail, road or air.

2. Dehydration:

Dehydration is nothing but mechanical method of removal of water. The water removed from the food product is to such an extent that the final dried product could be stored for a longer time. This is also basically a process that inhibits microbiological growth but does not destroy the organisms. Usually, below 10-15% moisture level on dry weight basis prevents microbial and mould growth.

3. Freezing:

Preservation by freezing depends eventually on two factors
a) below -8°C micro-organisms do not multiply;
b) below 0°C biochemical reactions are progressively suppressed - the lower the temperature, the slower the deteriorative reactions.

4. Chemical Preservatives:

a) Sugar as a preservative in the manufacture of jams. The fruits, sugar and water are boiled for a specific length of time so that a gel develops. The optimum acidity of the gel is pH 3. Sugar concentration is about 67.5%. Pectin is necessary during jam manufacture. This, in most cases is contained in the fruit itself. If, however, pectin content in the fruits is low, it can be added externally.

Salting and pickle fermentation are two other common chemical methods of preservation. Salting lowers the water activity of the storage commodity. The latter involves fermentation. The concentration of salt at about 2% by weight retards most bacterial growth. A few useful bacteria survive which release lactic acid and acetic acid. These assist in preservation.

Benzoic acid and benzoates, sodium metabisulphate are widely used in fruit juice manufacture and fruit-concentrate manufacture.

5. Irradiation:

Though sufficient researches have been carried out on the usefulness of irradiations in preservation, it has been successful only in a few products. In this process, the food stuffs are exposed to gamma rays for a specific duration. One of the major drawbacks of irradiation is the damage to the texture of fruits. They also carry traces of radioactive isotopes which are harmful.

CHAPTER - IV

SUMMARY
AND
CONCLUSIONS

The theme of this module being vast, only representative examples of preservation methods in rural areas were attempted. Analysis of the different storage structures provides the rural student information about the structures they generally see in villages. The urban boy too is benefitted by this because he would not have seen or known about the rural storage practices. Further, analysis of the basic scientific principles involved in storage and preservation is an indication of how simple teaching of science can be made by using the preliminary knowledge the rural youth would possess. It is actually a fusion between their naturally acquired talents, practices and the wealth of scientific information. The activities suggested in the module reinforces many of the scientific principles involved therein. Further, the evaluation items of the module triggers mental activity of the children, which is one of the basic objectives of teaching science. This valuable mental process not only helps him build up knowledge but also prepares him for a better and more meaningful scientific approach to life.

A rural farmer would hardly explore the possibilities of improving his storage structure because of his ignorance of the principles operating therein. The module also provides very simple and useful improvisations which the rural students can convey to the elders and parents in their family and the rural community. This not only popularises science further but would also reduce the losses due to contamination or deterioration during storage. Thus, science, which is otherwise too remote a commodity for the uneducated rural people is made available and taught to them in a way that they gain by it. It is this kind of education that is the need of the hour for our country in addition to the formal education.

As the module surpasses barriers of physical sciences, biological sciences and technology, it is recommended as a chapter in the curriculum of integrated sciences that is being designed for Indian School Education under the New Policy on Education.