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A unique way of Food preservation through traditional & modern methodologies

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Abstract

The fundamental need for grain and pulses storage is to protect them from rodents, insects, microorganisms and a well-built storage facility can easily do that. An efficient method of storage post the harvest season can empower the socio-economic scenario. People use traditional storage method for storing grains and pulses for their own need. These storage structures are comparatively cheap, eco-friendly and impart high shelf life to the stored commodities. These traditional storage systems could be applied in modern storage areas with minor modification, could save grains and pulses that would be damaged by insects. Though the chemical methods do save the grains and pulses but then they also leave behind toxic residues. The wisdom of farmers and people to store through traditional methods is more secure and protects the commodities from infestation for a longer period. It has been observed that different localities of India have storage methods that are peculiar to them. These are entirely based upon the wisdom of the locals who has the consciousness of the environment of their native place and their health.

Key words : Protection, Socio-economic Scenario, Traditional Storage, Modern Storage, Chemical, Chemical Residues, Environment, Health.

Traditional storage techniques were mainly used in ancient times and are still used up to now in developing countries. For instance, it is estimated that around 60–70% of the total food grains produced in India are stored in traditional storage structures (*e.g.*, Gourds, Sanduka, Kanaja, Kothi, Hagevu, Earthen pots, Gunny bags, etc.), especially in rural areas. Despite having a wide variety of traditional grain storage structures, India suffers substantial grain storage losses of more than 14 million tonnes every year. As these indigenous storage structures serve to store up to 70% of the total food grains produced in the country, the

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enormous amount of grain losses recorded in the country indicate significant gaps in their storage efficiency. Considering the criticality of this situation to the sustainability of agriculture, it becomes necessary for these traditional structures to be optimized.[4] Food preservation is the process of handling and treating food to control its spoilage by stopping the attack and growth of food-borne disease-causing microbes; avoiding oxidation of fats (rancidity); and maintaining the nutritional value, texture, and flavour of the food. Food preservation is also known as food processing.[16] It is commonly recognized that chemicals, bacteria from the surrounding area, and enzymes included in the food itself can cause food products to decay if they are exposed to them. In addition, food and food products must be carried from one location to another to be consumed. During transit, there are chances to deteriorate the food, loss or decrease in morphological attraction, and reduction in the nutritional value of the food. According to the World Health Organization (WHO), around 600 million people – roughly one out of every ten people on the earth – become unwell after eating contaminated food. Inadequate sanitation, insufficient food storage facilities, and food safety awareness make food-borne disease outbreaks in underdeveloped countries. It is the leading cause of morbidity and mortality all across the world. Conventional food preservation procedures such as drying, freezing, chilling, pasteurization, and chemical preservation are widely used worldwide and are becoming increasingly popular.[19] Scientific advances and advancements contribute to the evolution of existing technologies and the innovation of new ones, such as irradiation, high-pressure technology, and obstacle technology.[21]

Preservation techniques/methods

I. Traditional Preservation techniques/ methods

II. Modern Preservation techniques/ methods

I. Traditional Preservation techniques/ methods

1. Storage with ashes and table salt
2. Gourds
3. Kanaja/Galagi
4. Wooden Box/ Sandaka/Sanduka
5. Kothi
6. Hagevu
7. Earthen pots/bins
8. Mud silo
9. Bamboo baskets
10. Gunny Bags/Jute/ Burlap bags

I. *Storage with ashes and table salt :*

Indian farmers commonly treat food grains during storage with ashes produced from various sources, such as wood, cow dung, etc., in order to keep fungus and other hazardous insects at bay. Some farmers also treat food grains with regular table salts before storing them in various locally made facilities such as jute bags, earthen pots, etc. Countrywide, it is most commonly used. Advantage of this technique is they are more environmentally friendly, inexpensive, and readily available to farmers and disadvantage of this method are mostly limited to small- scale grain storage. They can be produced in huge quantities, packed in a variety of sizes, and used for small-scale and bulk storage of grains.[14]

A. *Red gram storage with common salt :*

Farmers with their indigenous knowledge used common salt in red gram (*Cajanus cajan*) grains storage. They had utilized a common available ingredient table salt in their house for storage purpose. In this practice, about 200 gm of salt was mixed for a kg of red gram grains manually. These treated grains were then stored in jute gunny bags and the bags were stitched. Due to this practice, insects were kept away from the stored grains. As salt had abrasive action on insect skin prevents its movement inside the storage containers. Farmers believed that this practice stored red gram grains, for short-term duration of 6-8 months. Farmers perceived this practice to be moderately effective and affordable in cost.

B. *Ash seed treatment in Sorghum :*

Ash was mixed with the sorghum (*Sorghum bicolor*) seeds at the ratio of 1:4. After the ash treatment, sorghum seeds were tied airtight in the jute gunny bags. During storage, grains were subjected to losses by various insects, *e.g.* rice weevil (*Sitophilus oryzae*), rodents (*Tatera indica*) and mite (*Oligonychus indicus*). Farmers strongly believed that ash application controlled these losses considerably up to an extent of 80%. Farmers using this technology stored the sorghum grains for 6 months without any storage pest problems.

C. *Ragi storage with neem leaves :*

Ragi (*Eleusine coracana*) is the main food grain crop grown by many people especially in the dry areas. Farmers used neem (*Azadirachta indica*) leaves in the storage of ragi. The strong odour of these leaves keep the storage pests like lesser grain borers (*Rhyzopertha dominica*), saw toothed beetle (*Oryzaephilus surinamemsis*) and flat grain beetle (*Cryptolestes minutus*) away. Being very cheap and simple most of the farmer followed this technology to get rid of storage pest than to relay on costlier chemical treatments. Neem leaves being organic repellents were also safe to use.

D. *Storage of grains using camphor :*

Both cereals and pulses attracted a wide range of storage pests. Hence, farmers indigenously practiced simple method in grain storage. In this practice, about 1gm of camphor piece per 5 kg of grains was placed as such in the jute gunny bags. This practice of placing camphor inside the grain storage bag repelled the storage pests due to the strong odour emanated from camphor. A short-term storage of grains up to 3 months was possible with this traditional storage method and after that the grains were to be sun-dried and then kept with fresh camphor pieces for subsequent storage.

E. *Storage of seeds with lime :*

Farmers traditionally followed a practice of storing pulse grains along with lime powder. In this practice, farmers dusted about 10 gm of lime per kg of grains. After thorough mixing they stored them in jute gunny bags. The lime had a property of emitting irritating odour that repelled insects and prevented the grains from damage. By this way, grains could be stored for even one year.

F. *Pulse grains storage with ash :*

This was an age-old practice being practiced for more than 50 yrs. Farmers indigenously stored pulse grains in earthen mud pots. For safe storage of grains, seeds were filled in earthen pot to its ¾th volume and then remaining top 1/4 th top was then covered with ash (wood/ cow dung ash). By this way, wide ranges of storage pests like pulse beetles (*Callosobruchus maculatus*), and fig moth (*Ephestia cautella*) were kept under the control for a period of 6-8 months. After 6 months, the grains were exposed to sun and then the ash was spread above the grains surface and kept for storage.

2. Gourds :

Gourds are produced from the tough dried outer shell of the fruit belonging to the squash or Cucurbitaceae class, which is native to tropical and subtropical regions. They are usually kept inside the house, especially in areas where they would not be easily infested with insects or exposed to moisture. Mainly it is used in Chhattisgarh. They are inexpensive, protect grains effectively, and allow farmers to easily track insect invasions. Their storage capacity is limited to 5 to 30 kg. Increase their size to enhance their capacity to hold more grains.[19]

3. Kanaja/Galagi :

Kanaja is a cylindrical grain-storing container made of bamboo and comes in a variety of heights. They are coated with a mud and cow dung mixture to avoid spills and misappropriation of grains. These kinds of structures are typically used in paddy- growing regions of the transition and hilly areas. Most commonly applied in Tamil Nadu, Karnataka, and other paddy- growing areas in rural India. They are situated above the ground, allowing for easy grain monitoring while protecting the grains from soil moisture. They are not ideal for preserving grains for lengthy periods it is a disadvantage of this method. Making them fully hermetic by adding an extra coating on their outer surfaces using readily available materials such as varnish, dry oil or pure cement will boost their ability to store grains for a long period of time.[27]

4. Wooden Box/ Sandaka/Sanduka :

These are wooden boxes used to store pulses, seeds, and small amounts of grains for domestic consumption. Their storage space ranges from 3 to 12 quintals. They are typically covered with a large lid on top which contains a small outlet for removing the grains. Mostly used in Uttar Pradesh, Himachal Pradesh, Rajasthan, Bihar, Jharkhand, Uttarakhand, Madhya Pradesh, Chhattisgarh, Tamil Nadu, Andhra Pradesh, Karnataka, etc. They are normally equipped with a locking mechanism to prevent grain theft, and are sometimes partitioned, allowing the same box to store two or three distinct species of grains. They are also built with a stand that keeps them a few centimeters off the ground to prevent the absorption of moisture. They can only hold a maximum of 1200 kg of grain, which is a relatively small amount. Increase their dimensions to enhance their capacity to hold more grains.[23]

5. Kothi :

This is a proper room constructed with

a large door for pouring grains. At the bottom of this room, there is a small passage that allows the grains to be discharged as needed. These structures are common in households where large-scale grain cultivation is practiced. In Himachal Pradesh, Madhya Pradesh, Bihar, and Karnataka it is commonly use. They can store relatively large quantities of grains, ranging from 1 to 50 tons. Since these structures are constructed of mud and paddy stalks, they can collect ambient moisture, which can lead to the development of aflatoxin in the stored grains. Coating these structures with a mixture of cow dung and clay, varnish, and, if necessary, even cement can improve their resistance to moisture absorption.[3]

6. Hagevu :

This is a grain storage facility that is situated underground. It is essentially a small pit that is enclosed in straw rope to keep moisture out. It is sometimes built with stones as an interior structure. In Tamil Nadu, Karnataka, and other areas in the dry agro-climatic zone use this method for preservation. They enable grains to be stored for longer periods of time without becoming contaminated by insects or fungi, eliminating the need for pesticide use. They are only suitable for arid agroclimatic conditions, where the stored grains are not endangered by water tables. These structures can be made versatile and adapted to various environmental conditions by elevating their neck a few centimeters off the ground and installing a well- designed drainage system to avoid precipitation infiltration.[3]

7. Earthen pots/bins :

These cylindrical structures constructed out of clay and carved to various sizes have been used for the storage of grains since ancient times. The pots' inside is coated with clay, and the mouths are sealed with a thick cow dung solution that has been stiffened with fabric. They are usually placed on top of each other in the house's corner. Uttar Pradesh, Bihar, Uttarakhand, Madhya Pradesh, Jharkhand, Chhattisgarh, Tamil Nadu, and other parts of South India are using this method. No insects can access the grains because the pots fit perfectly atop one another. Further more, they are usually put on top of structures bearing spherical shapes constructed of crop remnants or pieces of old clothes to avoid moisture absorption from the ground. They can only hold 200kg of grain at most, which is quite a small quantity. Increase their size to enhance their capacity to hold more grains.[6]

8. Mud silo :

Mud silos, which are generally spherical and typically consist of three or four stones as a foundation, are employed to store food grains for a brief period. The structure's storage volume ranges from 1 to 4 tons. They are often built using clay soil and sometimes termite mound soil. Method apply in Tamil Nadu and other parts of South India. They are inexpensive, hence easily accessible to farmers. They are susceptible to grain losses due to structural malfunctions as well as insect infestation since they are not airtight. They can be protected from rain and other adverse weather conditions by roofing them with low-cost materials, such as straw, palm leaves, etc.[19]

9. Bamboo baskets :

These are structures that are mainly

made of bamboo canes weaved into a basket form and contain a circular opening that allows the grain to move in and out easily. After loading the grains, they are usually covered with a mixture of cow dung and soil to create a hermetic atmosphere that keeps pests and insects at bay. In Himachal Pradesh, Madhya Pradesh, and South India this method is used. They have the ability to store grain for up to a year without losing its quality. They can only hold a maximum of 1000 kg of grain, which is a relatively small amount. Increase their size to enhance their capacity to hold more grains.[1]

10. Gunny Bags/Jute/ Burlap bags :

These are sacks that are made out of woven jute, sisal, cotton, and other locally sourced fibers. They are normally available in a variety of sizes, ranging from 20 kg to 100 kg or even more. They are inexpensive, simple to use, and don't require any specific storage space, so they may be kept anywhere in the house. Additionally, they can be easily managed and transported without the need for specialized tools. They are not airtight, hence do not provide complete protection against pest infestation, resulting in grain losses. Making them fully hermetic, *i.e.*, by adding an airtight layer inside made from synthetic or semi-synthetic materials that are less harmful to the environment.[1]

II. Modern Preservation techniques / methods

1. Nanotechnology
2. Hydrolysis
3. Dehydration
4. Pasteurization
5. Pulse Electric
6. High-Pressure Food Preservation
7. Hurdle Technology
8. Antimicrobial Agents
9. Microwave Heating Technology
10. Non-Thermal Technologies
11. Natural Organic Treatment

1. Nanotechnology :

Nanotechnology is a way of food processing in which we use nanoscale particles to process food. It is detrimental to both human health and the environment. This type of nanostructured substance can accumulate in the human body and lead to death. Through further investigation of the physicochemical and biological properties of these nano-sized particles, it may overcome these limitations. This ensures that the food retains its colour and that the solubility of vitamins is maintained throughout the production process. Active food packaging is also significant since it protects food from microorganisms[4]. SIO_2 is utilized as a scent enhancer in various foods, and beta carotene is used as a colouring agent. Still, it should be avoided in food preparation because it is highly unstable. Nanocomposites are made up of a variety of polymers, such as silicates, which are used to protect food from ultraviolet radiation when it is exposed to sunlight. Micro and nano biosensors are being utilized to detect food- borne infections and food rotting material in the food supply chain, among other applications[6]. People are not interested in fully or highly processed foods; rather, they are interested in foods that have been little processed. However, minimum preparation of food shortens the shelf life of the product because it increases metabolic activity (respiration), which results in a high concentration of ethylene and, consequently, increased

exposure to microbial agents[11]. Mango, for example, is processed and is commonly available in tropical and subtropical regions. Improving the shelf life of such minimally processed foods in cutting slices has been accomplished using chemical dipping and forming a pectin coat, which does not result in the softening and browning of meat or other flesh.[8]

2. Hydrolysis :

The process of reducing the activity of the pectinase enzyme is known as hydrolysis. If the pectin found in the cell walls of fruits begins to break down, the enzyme pectinase is produced, which results in food spoiling and softening as a result. The pectinase enzyme can also be activated by mechanical injury. The usage of Pectin methyl esterase prevents the rotting of fruit and vegetables. Pectin and alginate are the most often used coatings on food, and they are generally used on minimally processed foods to extend their shelf life and maintain their freshness for a longer period. Other approaches, some of which are conventional, are employed, such as physical procedures, some chemical methods, and biological methods.[2]

3. Dehydration :

Dehydration is a method of preserving food that is based on physical principles. Dehydration causes little water content and no microbial development. The process of evaporation is used to dehydrate the body. Because microorganisms and enzymes require specific water content to function, evaporation causes water loss, and microbes cannot damage food. However, this process also has limitations. After drying, some foods lose a lot of flavour and perfume. Drying depletes useful components such as vitamin C, thiamin, protein, and fat.[20]

4. Pasteurization :

Pasteurization is also used to keep food fresh for longer periods. The food item is heated in this procedure to kill the bacteria, extending the meal's shelf life. This approach kills all food spoilage bacteria; however, the temperature or heat duration should not be high enough to destroy vitamins and proteins. In most cases, the PEF treatment takes less than one second to complete. This technique was developed by the scientist Louis Pasteur, who was also responsible for developing the process of preserving milk and foods containing milk and other food. Modern procedures like PEF and HPP are also accessible.[14]

5. Pulse Electric :

A high-voltage pulse field is applied to food between two electrodes for less than a second, following which the food is withdrawn. This is known as the field pulse electric field approach. Other than that, it is effective in the killing of gram-negative bacteria. The presence of an electric field triggers the disintegration of bacteria's cell membranes. Because spores are resistant to this agent and therefore ineffectual against them, it is particularly effective against vegetative germs in particular. The electric field destroys the microorganisms' cell membranes. It kills vegetative microbes but not spores. Therefore it is useless.[5]

6. High-Pressure Food Preservation :

By modifying the shape of food particles, high-pressure food preservation is a procedure that solely changes the non-covalent bonds of food particles, therefore maintaining nutrition and preventing soiling. This method works by reducing the volume and enhancing the temperature[17].

7. Hurdle Technology :

Hurdle Technology uses various chemicals to inhibit or slow down the metabolic activity of food, and it is a type of food processing technology. This mixture contains a small number of preservatives. Temperature, water, pH, and a variety of lactic acid bacteria are just a few of the factors that can prohibit food from fermenting successfully in the first place. Irradiation and extremely high pressures may also be a source of the difficulty[9].

8. Antimicrobial Agents :

Antimicrobial drugs, which work by limiting the growth of bacteria, have also been utilized in the food preservation industry. These can be obtained from some plants or even by animals in some cases. Antimicrobial compounds found in plants, such as bacteriocins, kill gram-positive and gram-negative bacteria[6]. Lysozymes, found in eggs, are employed as antibacterial agents. Lactoferrin is an antibacterial agent. Animals are also a source of antimicrobial agents, as the Lysozymes found in eggs are used as a preservative in cheese production. Lactoferrin is also utilized as an antibacterial agent in some instances[19].

9. Microwave Heating Technology :

Microwave heating technology was used with the fruit to preserve kiwi puree to extend its shelf life while also maintaining its colour and bioactive ingredients. By using microwave heating, you can get better penetration power, a faster heating rate, and an increase in heating efficiency while simultaneously minimizing processing time compared to conventional heating methods, for example. As a result, compared to other conventional technologies, this technology is extremely successful in preventing microbial and enzyme degradation that causes harm to fruit plants while preserving the colour, bioactive chemicals, and antioxidants present in the fruit. As a result, this technique is used to produce safe, high-quality, and require minimal processing[24].

10. Non-Thermal Technologies :

When it comes to extending the shelf life of food and preserving the nutritional content of raw materials, non-thermal technologies are sometimes applied. Fish-eating has been increasingly popular in recent years, and items are increasingly being shipped to locations where seafood production is scarce[23]. In these circumstances, the preservation of seafood is critical to avoid the issues that may arise due to defective or rotten products from the seafood business. The following procedure is followed to preserve them[19].

11. Natural Organic Treatment :

When essential oil, tea polyphenols, and organic acid are added to marine food products, natural organic treatment has been

created that damages the pathogens and prevents their growth from occurring. Thyme, oregano, rosemary, turmeric, and shallots are some of the essential oils employed. Polyphenols in tea, including catechins and epigallocatechin gallate (EGCG), epigallocatechin gallate (EGC), epigallocatechin gallate (EGC), epigallocatechin gallate, epicatechin gallate, and epicatechin, can be extracted and have been shown to have antioxidant and antimicrobial properties that damage the pathogen. Organic acids like citric and lactic acid are utilized to extend shelf life and reduce pathogen impact[19].

Preservation techniques explain in ayurveda:

Preservative is a substance which is added to a formulation to prevent or inhibit the growth of micro-organisms in the preparation.[10]

1. Madhu (Honey) :

In most of the formulations Madhu is used as an ingredient e.g. Avaleha and Ayaskriti. Honey is active against bacteria, it creates viscous barrier against bacteria and infection.[13]

2. Sugar :

Sugar is used in many of the Ayurvedic formulations such as Sharkara Kalpana, Guda Kalpana and Khanda Kalpana. Sugar in high concentration causes bacteria to lose water by osmosis and it doesn't have any cellular mechanism to pump back the osmotic gradient. Being partly hydrolyzed into reducing sugar, it retards oxidation. In hypertonic solution sugar desiccates the cell retarding microbial growth and rendering potential pathogen inert.[5]

3. Self-Generated Alcohol :

Fermentation is an incomplete oxidation of sugar into ethanol and carbon dioxide in absence of oxygen brought about by the enzyme invertase secreted by yeast cells. The drugs which are used in Asava and Arista are preserved by self-generated alcohol.[4]

4. Lavana (Salt) :

Lavana is used as a preservative in Indian cuisine since time immemorial. Salt is considered to be possessing Anti-bacterial activity. As bacteria needs wet environment to grow, salt prevents the watery environment the bacteria needed to grow. This property is because the salt is very good at dehydrating and absorbing water from anything it comes in contact with e.g. pickle and Lavana Kalpana. Lavana Kalpana have infinite shelf life if stored properly.[6]

5. Desiccation :

Literally desiccation means 'to dry out completely', or to preserve food by removing the moisture. Here the water and heat liable extractive are extracted by continuous heating to remove the complete water content *e.g.* Ghanasara and Kshara.[14]

6. Anhydrous :

Literally anhydrous means 'without water or water of crystallization.' Here the wet drugs or moderately wet drugs are dried and powdered to remove the moisture content *e.g.* Churna Kalpana.[9]

7. Plant self preservation :

Guggulu contain resin and essential oil which act as preservative. It has healing property, antifungal and antiviral effect. The volatile oil present in it has anti- microbial activity. Adding of Guggulu in preparation of Vati Kalpana, increases its shelf life to five years.[17]

8. Antioxidant :

Auto oxidation causes rancidity and spoiling of formulation which leads to discoloration and change in taste, texture and odor. This leads to essential ingredient loss and shorten shelf life. Antioxidants which are present in pharmaceutical formulation prevent oxidative degeneration of drug and thus prevent rancidity. The antioxidants have great affinity to oxygen and when added to formulation they offer protection to other oxygen sensitive drug.E.g. Amalaki, Shatavari, Haritaki, Vibhitaki, Chandana, kumara. Tulsi, Brahmi,Yastimadhu, Ashwagandha, Haridra, Lashuna.[13]

9. Taila :

It contains naturally occurring preservative sesamol and sesamin. It contains Vit E which is rich in antioxidant. It contains high percentage of poly unsaturated fatty acid (PUFA) which helps to stay in liquid state at room temperature by preventing rancidity.[19]

10. Ghrita

It is used in many of formulations such as Sneha Kalpana, Malahara and Avaleha and so on. It is a rich source of antioxidant, it also contains beta carotene, vitamin A, D, E and K. Because of its antioxidant property it acts as a preservative. Ghritha is not hydrogenated or oxidized at room temperature.

11. Arka :

Arka is used as preservative in primary Kalpana like Kvatha. It is unique preparation in which essential oil from herbal drugs are extracted through distillation method. The essential oils and flavonoids present on the distillate act as a preservative.[12]

After detailed literature search about traditional and modern method of preservatives in food and Ayurveda formulations, it can be concluded that The preservative action of preparation is because of three important factors,

1. Ingredients used in formulation
2. Process involved in preparation
3. Methods of storage of medicine.

The protection of stored agricultural products against insect attack is essential for safe and steady supply of high quality food. Insect damage in stored grains and pulses may amount to 10-40%. In the past, insect infestation was often a less serious problem because farmers cultivated traditional varieties, which, although low yielding, were generally more resistant to attack by insects. However, the introduction of high yielding varieties has resulted in increased storage losses, as these varieties are usually susceptible to insect damage. Hence, storage of grains and seeds without pest infestation is essential. Indigenous practices has advantages over outside knowledge, it has little and no cost and is readily available. Considering food-borne diseases due to

consumption of spoiled food, proper preservation of foodstuffs is very important. Although many existing techniques are used for food preservation, considering economic viability and social responsibility, more effective and safer techniques must be searched. Also concluded from the above review that people have been using different traditional methods since the very beginning. With time to preserve various food items for different durations, several modern methods have also been developed that are working efficiently even though some processes have certain disadvantages and are being replaced by some other methods. We can store our food articles for longer without losing their flavour, nutritional value, and freshness.

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