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Efficient and Sustainable Processing of Horticultural Crops

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Horticultural crops are the primary source of carbohydrates, minerals, micronutrients, proteins, vitamins, lipids, fibre, organic acids, pigments, and antioxidants in human diet. Other than being a crucial element of a high-quality diet, a horticulture crops a means of producing revenue and reducing poverty for the farmers of underdeveloped countries. These crops can act as a fuel for economy of the developing countries. It is anticipated that the demand for fruits and vegetables will rise significantly in the future due to a steady rise in living standards and a growing consciousness of the need for nutrient-dense diet.

Rapid deterioration is the major cause of the low productivity of horticultural crops. Inadequate harvesting procedures, a lack of sorting to remove defects before storage, and the use of poor packaging materials all contribute to the issue. In general, minimising physical bruising, sorting products to remove diseased and broken items, and managing temperature effectively will all significantly contribute to preserving product quality and lowering storage losses. Storage life may be greatly increased if the temperature during the postharvest phase is maintained as near to the ideal as is practical for a particular item. For processing, then, high-quality product requires appropriate pre-harvest and postharvest technological practises.

Fruit and Vegetables Suitable for Processing

The majority of fruits and vegetables may be processed in one way or another. The demand for the processed goods, the raw material's ability to withstand processing conditions, and whether the products are seasonal or year-round availability are the key factors that decide whether processing is profitable. A fruit that is great to eat fresh might not be the best choice for processing. Processing often entails a lot of handling, pressure, high temperatures, peeling, and slicing, all of which can have a negative impact on the material's physical, chemical, and biological properties.

Requirements for carrying out Processing Operation

Selecting a site that reduces the average production cost, which includes handling and transportation, can increase revenues while also having a big impact on the quality of the processed goods. Placing the processing facility close to a new source of raw materials has benefits. It makes it possible to transport perishable raw materials with the lowest possible danger of harm and quality degradation.

Other essential requirements are a sufficient quantity of clean water, labour availability, accessibility to rail or road transportation sites, and a sufficient number of markets.

Processing Systems

1. **Small-Scale Processing:** Small-scale farmers undertake this as a cottage enterprise to sell in local marketplaces or for their own personal consumption. Although not very expensive, this type of processing takes a lot of time and is laborious. In several less developed nations, rural populations' requirements are met via small-scale processing. However, there is a demand for more processed and varied food kinds due to the growing population and increased trend towards urbanisation.
2. **Intermediate-Scale Processing:** This processing level involves the pooling of resources from several small-scale processors. Individuals are also capable of doing this. The technology employed by small-scale processors, which vary in terms of equipment type and capacity, forms the basis of processing. The raw ingredients are often contracted from other farmers or cultivated by the processors themselves. Urban locations can get large volumes of processed goods from intermediate-scale processing.
3. **Large-Scale Processing:** This system's processing is heavily automated and depends on a large supply of raw materials to run efficiently. High levels of administrative and technical expertise, significant capital investment, and sufficient, consistent raw material sources are needed for this system.

To varying degrees, these three types of processing systems complement crop output to supply food demand in various nations. However, in the past, small- and intermediate-scale processing in developing nations has shown to be more successful than large-scale processing. The type of industry, the size of the infrastructure for growth, transportation, labour, technology, and other resources available in various nations, as well as the marketing potential for the processed goods, all have a role in the choice of processing system.

Deterioration And Control

Fruit experiences complex changes throughout development as a result of its innate genetic makeup, which regulates the synthesis of growth regulators like ethylene and enzymes as well as external factors. Chlorophyll loss, the synthesis of coloured pigments, tissue weakening, and compositional changes are among the changes. Hence, a fruit is said to be "fully ripe" when it reaches a certain stage of growth. Senescence starts at a certain stage of development, and the fruit abscises the plant in preparation for seed release.

Any fully hydrated tissue has an expanded vacuole and cytoplasmic contents that are pushed up against the cell wall by the membrane. Vegetables lose their water supply after they are harvested, making them vulnerable to dehydration and frequent wilting. This condition may be made worse by increased respiration and transpiration brought on by wounding stress. The vacuoles contain the majority of the cell's water as well as carbohydrates, pigments, acids, vitamins, and minerals. The cell walls and membranes are damaged by cooking and freezing, which results in a loss of cellular integrity. Tissues become soft and wither as osmotic pressure is lost. Since certain vegetables, like broccoli and cauliflower, have blooming stems, methods must be used to stop the flower from fully developing, which might impair consumer acceptance and reduce crop value.

Ripening is also characterised by the tissues becoming softer. The fruit's greater susceptibility to physical damage from handling, pathogenic invasion, and crush injury from improper packaging and storage—all of which reduce shelf life—are the most concerning features of its softening. Additionally, changes in cell turgor brought on by variations in solute concentration and starch metabolism contribute to softening. Significant changes in the molecular structure of the plant cell walls as well as the component chemistry are expressed by softening. Fruit softening appears to be primarily influenced by the activities of several enzymes and components that cause cell separation and wall swelling in the middle lamella area.

Methods To Minimize Deterioration

1. Harvested vegetables are highly perishable and need careful handling and storage conditions to maintain quality. Quality can be lost quickly as a result of wilting from loss of water by evapotranspiration and excision of the plant parts from the roots. Stress on the crop associated with wounding from harvest can cause evolution of heat because of an increase in respiration. This can result in extensive heat damage and increased spoilage from microorganisms.
2. The field heat is the difference in temperature between the harvested crop and the ideal storage temperature for that commodity. Heat addition and removal are effective food preservation procedures. The removal of heat from food products by refrigeration results in preservation by slowing the rate of development of microbes. As a result, refrigerated foods may be preserved for a longer amount of time than non-refrigerated items left at ambient temperature.
3. Cooling the crop shortly after harvest to decrease field heat might prevent degradation by slowing respiration. However, cooling temperatures must be properly managed since this can cause damage, particularly to cell membranes, resulting in chilling injury responses.
4. Careless handling of harvested material might result in injury, pathogen introduction, and postharvest deterioration. Leaves, stalks, and flowers are fast developing organs that are not often adequately protected by a cuticle or thick epidermal layers like fruits are. As a result, there is minimal defence against water loss and fungal infection. The quality reduction caused by harvesting processes can be reduced by paying attention to postharvest circumstances. Lowering the temperature of the storage chamber and being able to transport crops to such storage as quickly as feasible are vital for delaying cell death. Furthermore, the closer the cold storage facilities are to the harvesting location, the better. Cool storage will also assist prevent water loss due to reduced evaporation and transpiration, although relative humidity management is also required. A moist environment near the surface reduces evaporation, but precaution must be taken to avoid condensation of moisture onto plant material, which would increase microbial development.

5. To minimise losses from inappropriate circumstances, it is vital that precise conditions are devised and maintained for each crop.
6. A variety of injuries and biochemical changes can occur as a result of improper storage conditions for both temperature and gases, and if the injury is internal, it may not be recognised until the fruit has been cut open.
7. Mechanical injuries caused by picking (fingernails), falling into bags and bins (bruises), abrasions from badly maintained bins, and compression injuries caused by overloading bins should be avoided. Injuries facilitate disease incursions, particularly fungus, and fungi thrive in restricted places with high humidity.
8. Any fruit may be preserved at temperatures slightly over the freezing point of the tissues. The freezing point is determined by the number of soluble solids (mostly sugar). The lower the freezing point, the larger the solids concentration. However, most fruits will freeze at or below 21 degrees Celsius. Storage temperatures are normally above zero for practical reasons. Chill damage occurs when storage temperatures go below the optimum for a species or cultivar. Chill damage is frequently invisible from the outside of the fruit.

Methods Adopted to Preserve Fresh Fruit and Vegetables

1. Hydrogen peroxide and hydrogen peroxide vapour can be used as sterilising agents for raw materials and packaging, as well as combined with other treatments such as nisin, although bacteria frequently develop intimate associations with the surface of the produce and are difficult to eradicate.
2. Mild heat treatment is an alternative, although it may change the respiration rate, accelerating decomposition or causing the development of phenolic components.
3. Preservatives are chemicals added to food that prevent or slow the deterioration of the food. Chemical preservatives, such as those that limit microbe development or lower their numbers and those that serve as antioxidants to minimise oxidative deterioration, are effective at extending the shelf life of horticulture goods. The most popular chemical preservatives include sulphur dioxide (SO2) or sulfites, as well as several organic acids known as parabens, such as benzoic acid, sorbic acid and its salts, and p-hydroxybenzoic acid esters.
4. To minimise microbial burden on fresh-cut pieces, UV light is often used instead of chemical treatments. The rate of respiration and lipase activity may be lowered, resulting in an overall improvement in shelf life. However, this treatment may have undesired side effects, such as activation of plant defence systems.
5. Irradiation may be effective for pest management, but the expense of plant setup and legal issues in certain countries may limit its usage.
6. Canning is an essential way of preserving food in general, and fruits and vegetables in particular, due to the increased shelf life it provides. It entails a significantly more intense heating procedure than blanching or pasteurisation. The procedure is intended to kill all bacteria, including their spores. This technique also necessitates the use of an airtight container to preserve the goods, which will prevent bacteria from entering and contaminating the food. The product may be processed within a container, such as a can, pouch, or bottle, or it may be packaged immediately after processing in a sterile environment.
7. Semi-processing is a viable choice for horticultural crop processing at the village level, and it is a significant processing technology in developing countries. Semi-processing horticulture items stabilises them for a certain period of time, allowing them to be shipped to large-scale manufacturers who can turn them into a variety of various end products.
8. Sugar preserved items include jams, jellies, preserves, conserves, marmalades, fruit butters, honeys, and syrups. They are fruit items that have been jellied or thickened. Sugar keeps everything fresh. Their particular features are determined by the type of fruit used and how it is prepared, the amounts of different ingredients in the combination, and the technique of cooking.
9. Juice is one of the most commonly consumed processed horticultural products. It is the

concentrated liquid extracted from fruits or vegetables.

Conclusion

Processing horticultural crops is a significant aspect of many nations' horticulture practises since it allows any item that is undesirable for the "fresh" market due to size, shape, or cosmetic defects to be used successfully. Most fruits and vegetables can be frozen, and many may be turned to pulps and juices and processed into shelf-stable goods that can be stored until at least the following season. Understanding the biology and chemistry of raw materials is critical for optimising the quality of processed products. Normally, fruits are picked at their peak ripeness.

Those used to make pulps and juices should be ripe. Vegetables, on the other hand, are often harvested when they are still young and delicate. When vegetables develop, their flesh becomes stringy and fibrous, and their seeds grow hard, rendering them inedible unless cooked for an extended length of time. Food safety has become a top priority in all processing processes, hence, to assure the quality and safety of the completed goods, excellent agricultural practises, GMPs, and HACCP processes are required.

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