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Preservation and Storage of Leafy Vegetables

Masterarbeit am Fachgebiet Agrartechnik

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Zusammenfassung

The perishability of leafy vegetables is a motivation of this study. The use of technologies that provide consumers with good quality and safe products as a constant supply of these high value crops have been made possible. Preservation and storage starts immediately after harvesting at optimum maturity. Harvested crops continue to metabolise and should be managed to preserve its sensual and nutritional qualities. Some minimal processing is necessary for the sanitisation of products by removing dead leaves, contaminated parts and insects before cooling and marketing. Products to be marketed are placed in wooden or plastic crates to avoid crushing.
Harvested crops are distributed differently depending on the variety. Systems have therefore been developed to suit each product. Losses must be incurred during transportation but good handling, temperature control, maintaining a good relative humidity and MA/CA is essential. Products that come into the warehouse first should be let out first. There are different methods involved in the preservation of leafy vegetables. Heat is applied through blanching and sterilisation to kill microbes and inactivate enzymes. Blanching negatively affects products when they loose nutrients like AA, and flavour. Conventionally water is used but recently microwave blanching is preferable due to the fact that nutrients are not lost. Heat application also results in drying products to a water content of about 10-15% through direct sun rays and solar driers. Drying is accomplished by the diffusion of water from the inside of the product to the surface when the surface moisture evaporates. The evaporation rate depends on the enviromnental conditions of air velocity, relative humidity and quality of heat supplied. Sterilising leafy vegetables with chlorinated water reduces microbial load but canned products are sterilised only by applying heat.
Cold preservation is involved in a chain of processes from harvesting to marketing. At each process stage optimum temperatures are maintained to preserve quality and avoid spoilage. Temperature is the most important factor that favours bacterial growth, aging and metabolism. In order to bring down temperature , pre-cooling is the first step taken by using water, room cooling, forced air cooling and vacuum cooling. It is necessary for cool rooms to be equipped with fans to force cold air through the products. Pre-cooling aims at removing field heat and heat of respiration. During transportation, top icing and vacuum cooling methods are essential.

Storage rooms are often placed where pre-cooling is done so that products are immediately transferred into the stores which are monitored to optimise storage enviromnental conditions. Avoid chilling injuries to minimise product deterioration.

Freezing is the most important cooling method that preserves quality and sensory attributes. Freezing to -l8°C or below begins with pre-cooling, crystallisation of water and the establishment of the final temperature. Fast freezing maintains good quality products because the crystals are kept uniform in the tissue cells. Freezing results to water losses that lower food quality but the overall changes that occur are better than those of other preservative methods.

Chemical additives preserve food but are themselves not supposed to be harmful to human health. Organic acids such as sorbic acid and phosphates could be used separately or in combination at the right percentages. Sauerkraut contains lactic acid that is secreted during fermentation. Preservation by modifying the gaseous atmosphere of a product such that the ratio of CO2/O2 is kept constant according to the product requirement reduces respiration and ethylene sensitivity. Packaging in polythene films also controls the rate of water exchange within the package and the environment. Care should be taken to prevent off—flavours caused by unwanted levels of CO2 that initiates the production of ethanol and acetaldehydes. Preserving and storing food by modifying the atmosphere should involve some food safety measures based on microbial activities.

The free radical antioxidant receptors of leafy vegetables bring about an oxidation/reduction potential that is able to control microbes. This is brought about by the acid electrolysis of water that takes place simultaneously with the basic electrolysis of water. The resultant acid solution formed has oxidising power and therefore induce an unfavourable environment for microbial growth. The basic solution with a strong reducing power is also used for cleaning utensils

Various preventive methods can be used in combination to prolong shelf life. Relative humidity, temperature, MA packaging, pH, and redox potential when combined at moderate conditions ensure that spoilage organisms can not cross all these hurdles to deteriorate a product. One or two of the most limiting of these factors will prevent further growth and development.

The quality of leafy vegetables deteriorates due to some biochemical reactions that take place. Ethylene production, oxidation, Maillard reaction and degradation of vitamins are

reactions whose mode of action leads to quality loss. Crops that are injured during harvesting and handling produce ethylene that induces yellowing of the leaves of both the affected and those with no physiological damage. Chilling injury caused by the unusually large crystals in the cells induce ethylene production that furthers the deterioration of products during freezing. Phenol oxidation catalysed by PPO induces enzymatic browning as the quinones formed quickly polymerises to dark-brown melanin. The melanin formed from the quinones is as a result of Maillard reaction in the presence of water and carbohydrates. Vitamin C declines rapidly in quality at unfavourable and prolonged storage conditions. It is therefore necessary to take control measures against deterioration by preventing ethylene production sources if economical, supplying fresh air to the products and the addition of chemicals like potassium permanganate to oxidise ethylene. Temperatures should be lowered to reduce metabolism and also modify the atmosphere of packages to the desired CO2/O2 ratio as an additional measure. Also, browning can be prevented by blanching or lowering the water content of leaves to below the 13% optimum.

Products on sale most have been produced transported and distributed to the various sales points. The chain of processes involved in marketing must then have a coordinated cool chain management and good handling practices that offer quality products to the market. Leafy vegetables contain biogenic amines that are used to indicate the level of microbial activities. When in high amounts it affects human health and also implies that there are microbes in the products and an increase in level will lead to microbial spoilage. In the production of sauerkraut, microbial activity produces putrescine a biogenic amine that does not indicate spoilage but good quality. Products predisposal to microbial deterioration is influenced by the type of vegetable, temperature, humidity and MA.

Bacteria are the most important spoilage organism after harvesting. Injured products provide easy access to microbes into tissues as much as handling introduces large amounts of these deteriorative organisms.
Spoilage of harvested products results from the contamination of healthy leaves by microbes from unhealthy ones. These microbes have a competitive advantage over pathogens which are therefore kept under control rendering products healthy for human consumption though some pathogens are resistant enough to grow and infect human beings. The nutrient content of leafy vegetables especially vitamins C and B-carotene is mostly influenced by climate and farm operations. Nitrogen in soils enables plants to build up

proteins as well as AA which is also favoured by potassium. Excess phosphorus and environmental factors like insufficient moisture in soils inhibit the production of AA. In low temperature zones and in longer light exposure, more AA is produced. Optimum maturity produces optimum yields of horticultural products regardless of the nutrient content Harvest uniformly mature crops manually for optimum quality though transportation and marketing facilities of wholesalers and retailers often expose products to below optimal conditions. Polymeric films are used for packaging and could be fortified according to the needs of the product with pleasing effects on sight and able to provide the desired effects. The cost effective nature of MA has made it more preferable to CA. MA in packages maintained passively or actively.
Production processes in all products have safety and quality regulations as a guide This is same with the preservation and storage of leafy vegetables. ISO is a private body whose regulations provide a guideline on safety and quality standards in most countries thereby encouraging international trade. Where public gades and standard are limiting, private ones are fully enforced like in Kenya.
Lettuce and spinach are leafy vegetables whose preservation and storage processes can be adapted to most leafy vegetables in the world. The technologies involved begin at harvest although good quality production starts from the cultural practices applied in the field. At harvest, large scale farmers use chemicals that stabilise quality. Harvested lettuce and spinach should be shaded from direct sunlight and immediately transported to the park house for cooling. These crops should be harvested manually to avoid injuries that enhance deterioration when suitable preservative and storage methods are used. Their shelf life is reduced by biochemical reactions like enzymatic browning though some minimal control measures with AA have been successful. Spinach and especially lettuce often have a high microbial load whose pathogens like shigella affect human health and should always be cleaned with chlorinated water.
Some recent advances have been made in the preservation and storage of leafy vegetables in Africa due to the increasing awareness of its economic vales nutritionally and financially. More so is the increasing buying power of the population and the changing technology and infrastructure as well as the facilitation of exporting facilities like reefer containers. Of greater significance are the advances made in the freezing technology.