Modern Food Packaging Technologies: Regulatory Aspects and Global Trends

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Welcome to the NPTEL online certification course on Modern Food Packaging Technologies, Regulatory Aspects and Global Trends. In the last lecture we have seen there are different types of form fill seal machines their working operations and uses. In the present lecture we will be discussing controlled atmosphere packaging of foods. And the topic of discussion will include introduction, history, purpose, working principle, equipment used in CAP, advantages and disadvantages. The controlled and modified atmospheric packaging can be used to can be used to the maintenance of optimum temperature and relative humidity for preserving quality and reducing post harvest losses of tropical fruits and vegetables. During transport and storage CAP or MAP reduce respiration rate, ethylene production to delay fruits ripening, composition changes associated with the ripening and incidence of some physiological disorders.

A reduction in concentration of oxygen and an increase in carbon dioxide concentration of storage atmosphere surrounding a food reduces the rate of respiration of fresh fruits and vegetables and also inhibits microbes. Controlled atmospheric packaging is a storage technique whereby the level of oxygen is reduced and carbon dioxide is increased. Quality and the freshness of fruits and vegetables are retained under controlled atmospheric conditions without the use of any chemicals. Controlled atmospheric packaging refers to a system whose objective is to extend the shelf life of food by altering the gaseous environment in and around the food.

Controlled atmospheric storage involves maintaining an atmosphere composition that is different from air composition generally oxygen below 8 percent and carbon dioxide above 1 percent are used. Under CA conditions many products can be stored for 2 to 4 times longer than usual. Now, the history in 1930s and 1940s fresh apples and pear were placed in enclosed warehouses the shelf life of apples extend up to 6 months after the original harvest which is about double the normal cold storage lives. In 1950s and 60s scientists from Whirlpool Corporation developed a method to control the atmosphere surrounding meat, fruit and vegetable products under refrigerated conditions. The concept called Tectrol that is total environmental control implying a gas burner to reduce the oxygen evolving air to the exterior to prevent oxygen extinction and permit the use of filters and scrubbers to remove excess carbon dioxide.

In the mid of late 60s 1960s hundreds of apple and pear warehouses throughout the world

where equipped with Tectrol system to extend the shelf life of the fruits. The Tectrol system was applied in transportation system of fruits and vegetables. Now, the purpose of CAP increasing the shelf life of food products maintaining the quality of freshness of food products, inhibition of pathogens growth in food products and control of the spoilage of food. Long time storage of food without using harmful chemicals for controlling biochemical and enzymatic changes in food products. Now, the working principles of controlled atmospheric packaging.

It reduce the rate of respiration, reduce the microbial growth and retard enzymatic spoilage by changing the gaseous environment surrounding the food product. Gaseous environment is achieved by reducing the concentration of oxygen which is required in respiration or by adding an inhibitory gas such as carbon dioxide or carbon monoxide. The balance between oxygen and carbon dioxide is critical and an optimal ratio is required for each specific product. The gas concentration in CA storage generally 1 to 10 percent of oxygen, 0 to 30 percent of carbon dioxide and balance is nitrogen. This picture gives the equipment used in CAP.

This is equipped with the carbon dioxide scrubber, ethylene scrubber, nitrogen cylinder and the gas controller. The fans which equilibrate the relative humidity inside the chamber, then temperature controller and the humidity controller and this will be discussed in the following slides in detail. The scrubber, the unit consists of an activated carbon filter chamber, a low pressure ventilator and air transport system, a control unit and a buffer or lung system. It is of two types such as carbon dioxide scrubber and oxygen scrubber. The carbon dioxide scrubber, when the carbon dioxide labour reaches above the carbon dioxide set point, the scrubber blower will activate and evacuate carbon dioxide with the selective scrubber bed.

A carbon dioxide scrubber removes the carbon dioxide from the storage cells in order to prevent concentrations getting too high and causing damage to the fruit. Carbon dioxide scrubber determine which situation is suitable for specific food item. Now, the oxygen scrubber, it uses oxygen and produces carbon dioxide and oxygen scrubber reduces the oxygen level in the storage area after the moment of storage or after the interim opening of the cell in order to inhibit respiration and extend the self storage period. Oxygen scrubber is suitable for situation preferred storage conditions. When oxygen level goes below the oxygen set point, the fresh air valve will open and let in the compressed oxygen.

Ethylene converter, when the ethylene level goes higher than ethylene set point, the scrubber blower will activate and evacuate ethylene with the selective scrubber bed. Fruit varieties that are sensitive to ethylene under CA conditions such as kiwi requires an ethylene converter. The ethylene converter uses oxygen to convert ethylene into carbon

dioxide and water, both inert substances. The gas analyzer, the gases such as oxygen and carbon dioxide are analyzed by meters which are fitted into the operating system. In built meters offer three types of measurement methods.

First is galvanic cell which is a electrochemical instrument cell which is electrochemical measurement cell and is suitable for measuring low carbon dioxide level and often used for hard fruit and kiwi storage. The another is zirconium cell which is suitable for measuring higher carbon dioxide values, but not suitable for measuring high ethylene concentration, often used for berry storage. Now the paramagnetic cell and it can measure very accurately often used within laboratories. Now humidifiers, water management, most fruit varieties are stored under high relative humidity that is above 95 percent. Moisture loss can limit the storage quality of fruit in a cool cell.

Measuring moisture loss, fruits that is stored in a shear losses moisture. This moisture loss reduces if relative humidity levels are kept above 90 to 95 percent. So one should maintain an overview of moisture loss within a storage cell. Over and under pressure valve, in this case an over and under pressure valve will take up the pressure difference in the storage area in order to prevent damage. Every cool cell used for shear storage needs at least one under and one over pressure valve.

Numerous valves will be used for large cells. When the oxygen level goes below the oxygen set point, the fresh air valve will open and let in the compressed oxygen. Scrubbers are connected to the cool cells via PVC pipes. Gas tight doors, the doors of shear cool cells are a crucial element of storage under low oxygen concentrations. A small leak means percentage of less than 3 percent oxygen will not be achieved.

So gas tight doors guarantee oxygen level less than 0.5 percent as a result of using a special rubber inflatable profile. Small deformities in the wall and the floor no longer present any problem. The gas tight doors can be supplied in a horizontal and vertical format. The maximum level of carbon dioxide and minimum level of oxygen for storage of different fruits and vegetables are presented in this table.

Like for example, apples the oxygen and carbon dioxide levels both should be maintained at 2 percent whereas, for the avocado oxygen 3 percent, carbon dioxide 5 percent, banana no oxygen level is required and 5 percent should be the carbon dioxide level. For cabbage oxygen 1 percent and carbon dioxide 5 percent, for cauliflower 3 percent oxygen and 5 percent carbon dioxide, for citrus fruits oxygen levels should be maintained at 5 percent no carbon dioxide, for onion 1 percent oxygen and 10 percent carbon dioxide. For potato both carbon dioxide and oxygen should be maintained at 10 percent, for strawberries 2 percent oxygen and 20 percent carbon dioxide, sweet corn no oxygen 20 percent carbon

dioxide, tomato 3 percent oxygen and 20 percent carbon dioxide. Advantages of controlled atmospheric packages, reduction in chlorophyll breakdown which results in higher color stability, reduction in enzymatic browning in cut produce whenever low levels of oxygen are used. Improvement in texture caused by the action of carbon dioxide on enzymes acting on the cellular membranes, reduction in some physiological disorders for example, chilling injury of citrus fruits, avocados, chili peppers etc and reduction in microbial activity especially molds.

The marketing and distribution advantages of CA technologies include reduction in fresh food spoilage and quality loss through the distribution at the retail level, expanded radius of distribution system and market area, improved branding options and product differentiation, potential for increased profitability in all fresh or chilled food operations. There are certain disadvantages also which are associated with capped packaging that is the high initial cost of air tight storage, high cost of generation and transportation of the gas, requirement of special types of equipment, interaction of CA gases with the structure of the storage which may cause some practical problems, more risk as to modified atmospheric packages. Thank you that is all for today. Thank you very much.