PACKING OF BEEF, MUTTON AND PORK

Welcome to the lecture on food technology. In today's lecture you are going to understand about the packaging of beef, mutton and pork.

By the end of this session you will have an understanding of the following:

1. Consumer acceptance of meat
2. Strategies in meat packaging
3. Packaging of beef
4. Packaging of mutton
5. Packaging of pork

Introduction

Since a long time meat, has been considered as a highly desirable and nutritious food. Unfortunately it is also highly perishable as it provides the nutrients which are needed to support the growth of many types of spoilage microorganisms.

If meat (beef, mutton, pork) is appropriately packed it can confer a number of benefits. Extended maintenance of quality can be achieved in an hermetic package through exclusion of contamination, delaying of microbial spoilage, maintenance of desirable color and by the minimization of water loss. The extension of storage life makes possible a broader geographical distribution of other packaged meat products as well. Proper packing also facilitates easier handling convenience, improved presentation for retailers and the provision of a surface on which attractive information graphics or customer information, product content data etc can be printed.

Realization of these benefits is contingent upon the correct selection of packaging materials and systems. The specific requirements depend on whether the product to be packed is either fresh or processed meat, whether it is beef, lamb or pork, whether it is cooked or uncooked, boneless or bone-in and on whether it is destined for local retail display or for transport to overseas destinations.

1. Consumer acceptance of meat

Appearance is one of the most important attributes by which consumers tend to judge the quality of meat. Hence, the deterioration of color is one of the prime factors that limits storage life. Meat should hence be packed in a manner that retains its appearance and presents it in an attractive way. According to studies, there is no direct relationship between color and other properties such

as tenderness and juiciness. Once the consumer has purchased the meat, the other properties such as odour, flavor, tenderness, juiciness etc then become important. Good packaging techniques should maintain the appearance of meats during storage and also delay microbial spoilage.

Consumers have several indicators which help determine the quality of meat. In addition to color and odor changes, which is indicative of an end of shelf life, code dates are included on fresh meat packages which have all the necessary details such as date of manufacture or expiry.

The multiple functions and variety of packaging technologies available for consumer products creates challenges for those who design meat packings, including fresh, cooked or frozen meat products. Meat products may be stored under a wide range of conditions such as refrigeration, freezing and intense lighting and it must be able to withstand these conditions and handling abuse.

2. Strategies in meat packaging

The properties of the various groups of spoilage microorganisms suggest strategies which should be implemented in attempting to preserve meats by the use of appropriate packaging systems. On meat of normal pH, the environment restricts bacterial growth and in normal pH range only lactic acid bacteria grow to a population capable of causing spoilage. But, if the meat has a higher pH, other spoilage organisms can grow and cause more rapid spoilage. In order to restrict growth on high pH fresh meat, atmospheres of carbon dioxide may be used.

In case of processed meats, a combination of manipulation of water activity with control of the gas atmosphere can be used. For instance, the minimum water activity at which Brochothrix thermospacta can grow in the presence of oxygen at 00 c is 0.94 whereas in the absence of oxygen it is 0.97. Addition of lesser amount of salt to meat products also prevents the growth of this particular organism. Also, this organism is sensitive to the inhibition by nitrite in cases when oxygen is absent. These facts point to the advantages of packaging processed meats so that little or no oxygen is present.

The above principles speak of methods that can be used to control microbial spoilage. The practical end result to be aimed at in all the cases should be the creation of conditions in which lactic acid bacteria can be the only group of organisms which can readily thrive. The presence of such flora dominated by the lactic acid genera can normally be expected to signify a maximum shelf life for packaged fresh meat.

3. Packing of beef

Vacuum-packaged primal cuts

It is common to store and distribute chilled beef as primal cuts (2 to 9 kg) vacuum packaged in bags made of plastic materials having low permeability to gases. Beef which is packed in this manner is easy to handle. The color of such beef is preserved and the storage life gets greatly increased. Inside a vacuum package, the residual oxygen is consumed, presumably by the tissues and microbial consumption of the oxygen. In turn, carbon dioxide is produced. If the process of vacuum packaging has been correctly followed, there is little head space left in a vacuum package. This makes accurate gas analysis difficult, but the atmosphere contains less than 1% oxygen, about 20 to 40% carbon dioxide and the remainder being nitrogen.

Beef stored vacuum packaged in low permeability films should be purple in colour since the myoglobin content is in the reduced form. If a brown color has developed during storage it is indicative of excess oxygen penetration into the pack. This can be caused either by the use of a film which is excessively permeable or due to the pack being a “leaker”. When vacuum packs of beef are opened, the purple colour should turn into red colour which is termed as return of the “bloom”.

Table 1. The storage life at 00 c of vacuum packaged primal cuts beef, lamb (mutton) and pork.

Type of meat	Muscle pH	Storage life (in weeks)	Spoilage defect
Beef	5.5 – 5.8	10 - 12	Flavor (souring)
Pork	5.5 – 5.8	6	Flavor
	6.0 – 6.3	4 - 6	Colour (Greening)
Lamb (mutton)	Not applicable	6 – 8	Colour, appearance of fat

The above table gives estimates of the maximum commercial storage life at a temperature of 00 c of vacuum packaged primal cuts of beef, pork and lamb mutton. These are only obtained provided:

1. The meat is produced using good manufacturing practice (initial total count of organisms able to grow at 0 – 50c is 102 – 103 / cm2 or less.

2. The packaging film which is used should have a low permeability to gases (< 50 ml of oxygen per square meter of film per day per atmosphere of gas pressure, measured at 250c and 98 per cent relative humidity.

3. There is good control of temperature i.e. temperature should be optimally maintained during the storage period.

Vacuum packaged beef of normal pH shows very little signs of visual deterioration during 12 weeks storage at 00 c. The use of analytical taste panels has shown that spoilage is largely due to aroma and flavor changes. The most significant change is the development of an “off” flavor or typical flavor in the cooked meat which becomes evident after storage for about 10 weeks.

Studies have revealed that vacuum packaged beef of normal pH also spoils due to the development of a flavor defect. However, this occurs after about 6 weeks at 00 c. When beef pH is about 6.0 or higher, a number of other types of bacteria may reach populations high enough to cause spoilage. In particular, the growth of Alteromonas putrefaciens, Aeromonas, or some types of Enterobacteriaceae may cause spoilage due to a colour defect termed as greening. These organisms produce hydrogen sulphide which reacts with myoglobin to form sulphmyoglobin which is responsible for the formation of green colour. This results in discolouration of the weep and green areas tend to appear over the fat surface. This defect is much more predominantly noticeable in beef as the higher concentration of myoglobin means that the green colour is more intensely visible. This type of spoilage has often led to the rejection of vacuum packaged meats in overseas markets.

Holding of beef at higher temperatures reduces storage life. Usually, storage at about -10c is recommended whenever possible.

4. Packaging of mutton (lamb)

Vacuum packaged telescoped lamb carcasses

A method known as telescoping is used to pack lamb carcasses in which the size is reduced. In this process, the hind legs are folded up into the thoracic cavity and by this a considerable reduction in volume is achieved. This also reduces transportation costs incurred. However, there are still voids in the packs and gas analysis typically show the presence of 1 – 3 per cent oxygen in the atmosphere of these cavities. This, coupled with the considerable volume of exudates (typically pH 5.9 – 6.1) which commonly collects, creates problems of a microbiological nature. The storage life of lamb carcasses packaged in this manner is about 6 weeks at 00 c. Greening may terminate storage life.

Gas – flushing of primal cuts and telescoped carcasses

Gas flushing with 100 per cent carbon dioxide results only in a marginal improvement of storage life and quality of vacuum packaged primal cuts. This is because there is little head space and

only a very low concentration of oxygen is remaining. But in the case of telescoped carcasses, it largely removes residual oxygen and hence there is an improvement in storage life to about 8 weeks at 00 c.

Decontamination of primals and telescoped carcasses

If the carcasses or cuts of lamb meat are treated to reduce the microbial load prior to processing, the storage life can be extended. Hot water may be used to decontaminate but dilute solutions of lactic or acetic acid are much more effective.

Lamb carcasses may be treated “on line” in the abattoir prior to chilling. If such unchilled carcasses are immersed in a 1.5 per cent solution of acetic acid at 550 c for 10 seconds, there is a reduction of 95 – 99 per cent in the population of bacteria on meat. The acid treatment not only reduces the number of bacteria present, but also has a residual effect. It delays the onset of the growth of putrefactive bacteria i.e. it has a bacteriostatic effect. These effects result in an extension of the storage life of telescoped carcasses to about 10 to 12 weeks.

A solution of lactic acid may also be used in the concentration of 2 per cent at 550c for 10 seconds. This would cause a similar reduction in the degree of contamination to that obtained with acetic acid. However, the residual effect during storage of the vacuum packaged meat is not as great.

Multiple pieces of meat vacuum packaged in one bag

There may arise a need to extend the storage life of boneless fresh meat, and the muscles involved may be too small to warrant individual packaging. The storage life of smaller muscles bulked and packaged together will always be shorter than that of a single muscle or cut, of the same weight and pH. The shorter storage life is largely caused by the greater surface area on which bacteria can grow when multiple muscles are present, i.e the surface to volume ratio is greater. In some of the meat is of a higher pH range, and this is likely with pork, packs containing multiple muscles should be stored at 00 c (when the storage life under commercial conditions will be 2 – 3 weeks) or as close to this temperature as possible. If it is stored at 50 c, storage life could be as short as 7 – 10 days and this may not be sufficient to make the practice worthwhile.

Consumer cuts

In many countries, there is a demand for meat that is bright red in colour. This applies to beef and lamb but may be less critical with pork because of its lower pigment content. A major challenge in meat packaging has been to ensure that the consumer is presented with meat, the colour of which meets his expectations.

There are 3 types of packaging suitable for the presentation and display of consumer portions of meats. These are:

1. Conventional overwrapped trays

2. Modified atmosphere packaging (MAP)

3. Vacuum packaging

The last two types of packaging have been little used, but are common in some European countries. Conventionally overwrapped trays are usually made use of in supermarkets. Supermarkets traditionally present retail cuts for display in semi-rigid plastic trays overwrapped with a clear plastic film, which is readily permeable to oxygen. Pseudomonas bacteria grow and cause rapid spoilage. Brochothrix species is also a predominant problem. However, bacterial spoilage of consumer cuts in overwrapped trays stored under retail display conditions does not limit storage life; this is actually caused by deterioration in appearance. Development of browning causes “fading” and a “tired” appearance and this limits display life to a maximum of 3 days. In practice, supermarkets restock retail display cabinets on a daily basis to ensure the meat has a fresh appearance.

5. Packaging of pork

Pork retailers use a wide variety of packaging to merchandize fresh pork. A general category of packages known as case-ready has increased in numbers over the last few years. Case-ready describes a package sent from the pork processing facility that requires no repackaging in the store before being place in the meat case. Case-ready packages are available in several types such as modified atmosphere and vacuum packages.

Modified atmosphere packages house pork products in an environment other than air. Modified atmosphere packages typically are rigid plastic trays, which hold the meat product and an absorbent pad, which has been sealed with a clear high-barrier plastic film. During the manufacturing of these packages, a machine will vacuum residual air from the tray and then flush the tray with a modified atmosphere immediately prior to sealing the package with the clear film. The modified atmospheres typically consist of purified gases found in air such as oxygen, carbon dioxide, nitrogen and carbon monoxide and each gas has a distinct use or purpose. Nitrogen has no effect on meat color or bacteria growth, but is used as a dilutant allowing other gases to be used in proper ratio. Oxygen is used because it causes the bright red color consumers prefer. Carbon dioxide is used to decrease or prohibit the growth of spoilage bacteria. Carbon monoxide was approved for use in 2002 by the FDA and USDA at a level of 0.4% and works with myoglobin to form a strong bond that creates a red color. Carbon monoxide is approved for use in a gas mixture that does not include oxygen and the result is a decrease in oxidation, which creates a stabilizing effect and increases case-life. The most common modified atmospheres consist of 80% oxygen / 20% carbon dioxide or 0.4% carbon monoxide / 30% carbon dioxide / 69.6% nitrogen.

Another form of modified atmosphere packaging is vacuum packaging. This packaging method involves the use of a plastic pouch or bag made from materials that provide a strong barrier of protection against abrasion, moisture migration and gas permeability. Pork cuts are placed inside the plastic pouch, placed in a packaging machine that removes the residual air from the pouch and immediately seals the pouch to prevent air from returning to the package. The vacuum-packaged pork is usually placed in hot water for a brief time, which causes the excess edges of the pouch to shrink around the pork cut; improving the appearance and strength of the package. Because vacuum packaging removes the oxygen from the package, vacuum packaged beef cuts usually are purple-brown in color. Consumers are not accustomed to purchasing purple colored fresh beef, so vacuum packaging at retail is typically reserved for beef cuts that have a permanently fixed color. Fixed pork colors can result from cooking or curing. In recent years, consumers have begun to accept the vacuum packaging of a few pork cuts. The lack of oxygen in the package greatly increases the case-life of vacuum packaged pork because of decreased oxidation.

Traditional Packaging

The most common form of fresh meat packaging at retail is called store wrap. Surveys show that approximately two-thirds of fresh meat packages are store wrap, but this number is declining each year due to the availability of case-ready packaging. This packaging technique received its namesake because bulk, vacuum-packaged pork or any meat is delivered, portioned and repackaged for display when it arrives at the retail store. The package consists of a foam tray, which holds the beef and absorbent pad, wrapped with a clear atmosphere-permeable plastic film. The permeability characteristics of the film allow oxygen from the air to come in contact with the pork; changing the color of the meat. This package type is very economical and utilizes cost-effective equipment. However, it possesses the shortest case-life among package types because the continued exposure to oxygen promotes oxidation and the lack of significant levels of carbon dioxide in air does not suppress spoilage bacteria growth.

Other types of meat packaging can be found in the retail case. However, these package types can generally be classified as a form of vacuum packing or gas-flush modified atmosphere packaging.

Summary

In order to understand meat packaging, it is important to understand the needs of the meat product to be marketed. Research has shown that meat colour is a primary factor affecting consumer purchase decisions and the most favorable meat colour is red. Meat contains the protein myoglobin, which is responsible for bringing about the change in colour. Within its structure, myoglobin contains iron and a binding site for various biochemical components to attach. The state of the iron and the nature of the components attached to the binding site determine the colour of the meat.

Consumers have several indicators available to determine meat freshness and quality. In addition to colour and odor changes associated with the end of case-life, code dates are included on fresh meat packaging labels. Code dates indicate when a package should be sold or consumed in order to ensure freshness.

There are several practices uses in packaging the different types of meat (beef, lamb meat or mutton and pork) such as vacuum packaging of primal cuts, vacuum packaged telescoped lamb carcass, gas-flushing of primal cuts, modified atmosphere packaging etc.