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 were studying the packaging of meat and poultry products and in the present lecture we will be studying the different meat products packaging. And in this we will be covering packaging of frozen meats, packaging of cured meat, packaging of thermo processed or cooked meat and packaging of dehydrated meat. The packaging of frozen meat, major portion of exports of meat from India is in frozen meat form. Preservation of meat by freezing offers the greatest advantage of increase in shelf life, inhibition of bacterial growth and preservation of fresh texture and flavor.

If frozen meat is not properly packed there is continuous dehydration from the surface resulting in freezer burn. This condition affects the surface texture and color. Meat fat is also prone to the development of oxidative rancidity if a good oxygen barrier is not used. This is the global frozen food market which is projected at around 4.8 percent cumulative annual growth rate during 2022 to 2027. Based on the distribution channel hyper markets and supermarkets are anticipated to acquire the largest market share during 2022 to 2027. But the challenges faced by this is increasing health concerns and the easy availability of fresh and natural foods. The second challenge is the fluctuation in the nutrient level of fresh and frozen food shifting consumer focus. But at the same time the drivers are increasing population and its massive food requirement.

The working people preferring frozen food as a convenient option with minimal or no preparation time. The emerging trend of veganism stimulating the demand for frozen food and the segments are that is that based on the product type the frozen meat, seafood is anticipated to dominate the market with the largest share during 2022 to 2027. And reason wise also the Europe is anticipated to dominate the market with the largest share during 2022 to 2027. And the big players in this frozen food are Aginomoto foods, Conagra brands, Frosta AG, General Mills Inc etc. The global frozen meat markets actually in 2022 the US contribute about 23.

2 billion US dollars. The market drivers are robust demand for ready to eat meals, increase in penetration of e-commerce and online delivery services and the product which are generally marketed are beef, chicken, pork and other products. The

cumulative annual growth rate is expected to increase during 2023 to 2031 at the rate of 3.6 percent. And here also the key players are Kerry groups, PLC, Tyson foods, Marfrig groups, BRFSA etc.

Hence the frozen meat needs protection against dehydration and loss of surface texture, moisture loss, temperature fluctuations, rancidification, pick up of odors and flavors, expansion and contractions which occur during freezing and thawing. Frozen meat is stored and displayed between minus 10 to minus 30 degree Celsius at which temperatures microbiological growth is arrested. Therefore, the changes in meat most influenced by packaging are those associated with appearance with color and absence of frost inside the package being the two most important features in this regard. If a bright red color is required then it must be produced by oxygenation of the meat surface before freezing followed by packaging in a material which is relatively permeable to oxygen and it has been claimed that inomer films will keep the bright red color for at least a year if the meat is stored in the dark as minus 20 degree Celsius temperature. However, when exposed to light the red color begins to darken after about a week.

This is caused by light activated oxidation of the pigment in the meat surface and is inevitable in meat which has been frozen in the bright red state and subsequently exposed to light. When frozen meat and meat products are stored without an adequate moisture vapor barrier an opaque dehydrated surface known as freezer burn is formed. Freezer burn is caused by the sublimation of ice on the surface of the product which is presented in the adjacent picture. When the water vapor pressure of the ice is higher than the water vapor pressure in the surrounding air inside the package. Histological studies have revealed that the spongy freezer burn area in frozen muscle and liver possesses microscopic cavities which scatter light.

These cavities were previously occupied by ice crystals. The key to avoiding freezer burn and lessening oxidative deterioration during frozen storage is to eliminate or reduce the head space in the package which should also serve as an effective barrier to oxygen and water vapor. Freezer burn can occur even when using a packaging material which is an excellent barrier to moisture vapor if the package head space has not been essentially eliminated. Executive changes are even more effectively reduced though exclusion of air by means of vacuum packaging. Several packaging systems are available that satisfy the aforementioned requirements for frozen meat.

Vacuum packaging followed by heat shrinking of the package has been available for many years because there is no space between the meat and the packaging material. Frost cannot develop to mask the attractive appearance. When the meat is frozen prior to VSP that is the vacuum skin packaging the final radiant heat sealing operation glazes the

surface of the frozen meat and produces an appearance similar to that of chilled meat. Restructured meat products can be manufactured by following three methods chunking and forming, flaking and forming and tearing and forming. Flaked and formed products are normally either cured and heat processed or fresh frozen.

Cured products include sauces and loaves. Fresh products are saved by stuffing into casings or forming into locks. Flaking and forming processes are normally used only to make fresh products such as sticks, cutlets, chops and roasts. Now, the packaging requirements a suitable packaging material must therefore, have a very low moisture vapour and oxygen transmission rate. The material should also be durable at freezer temperature have very high wet strength and be in permeable to odour and flavours.

Plastics are amongst the most commonly used materials for packaging of frozen meat. Generally low density polyethylene of 150 to 200 gauge is used for this purpose as it provides adequate clarity and is stable at low temperatures and is available at low cost. Polyester or nylon PE laminates and heat shrinkable low density polyethylene and PVC, PVDC copolymer films also provide functional properties. Besides giving neat appearance to the frozen meat cuts. Shrink packaging also allows convenient handling of the product.

Frozen meat may be in the form of chunks minced or various cuts. The unit packs consist of 1, 2, 4 or 8 pounds in LDPE bags of 250 to 350 gauge. After placing the meat in the bags, the bags is folded and then the packed product is blast frozen at minus 40 for a period of 4 to 12 hour depending upon the size and shape of the package. After freezing unit packages are packed and stored in corrugated boxes made of either paper or plastic which are either waxed internally or on both the surfaces. These boxes are stored at minus 20 degree Celsius and the expected shelf life for the product is around 1 year.

Now, the packaging of cured meat. A significant volume of meat products are cured. Therefore, an understanding of the changes meat pigments undergo during the curing process is important. A cured meat is one to which sodium chloride has been added and in which the native meat pigment that is myoglobin reacts with nitric oxide mainly in the nitroso form. The precursor of nitric oxide is either sodium nitrite or potassium nitrite which may be added directly or result from nitrate reduction.

The nitrate is also an oxidizing agent and rapidly converts myoglobin to metmyoglobin. Nitric oxide then combines with metmyoglobin to form nitrosylmetmyoglobin which is then reduced by various reducing agents such as added ascorbate to nitrosylmyoglobin. Nitric oxide also reacts directly with myoglobin to form nitrosylmyoglobin. This is the pictorial diagram that myoglobin which is purple in color directly react with the nitric

oxide to give the nitrosylmyoglobin. And this nitrosylmyoglobin upon heating it becomes nitrosyl hemochromes which is pink up in the color or this myoglobin it can react direct with the nitrite and to form metmyoglobin which is brown in color which again react with the nitric oxide and changes to nitrosylmetmyoglobin which is red in color which is further reduced to nitrosylmyoglobin which is again red in color.

The attractive red color of cured meats before cooking is essentially that of nitrosylmyoglobin. It has the red color characteristics of fresh meat that is the oxymyoglobin. Heating converts nitrosylmyoglobin to denatured globin that is nitrosyl hemochrome which is stable and characteristically red pink in cooked and cured meats. Residual nitrite is required at the time of cooking and bacon with low or zero nitrite at the time of frying may be gray after cooking. In traditional processes nitrate has the only source of nitrite which was formed by the action of bacteria mainly micrococaine on the nitrate.

However, in modern rapid cure processes nitrite is added directly to the brine and a proportion of nitrate may also be included. During storage cured meats deteriorate firstly because of discoloration, secondly because of oxidative density and in the fat and the thirdly on account of microbial changes. The latter having become of somewhat greater importance since the advent of prepackaged method of sale. To inhibit color changes in cured meat products a lower level of available oxygen than the required to shift the microbial population from aerobic to anaerobic is required. In cooked meat roasts nitrogen packaging significantly improves the appearance by retarding greenish discoloration.

Light increases the frequency of green discoloration of vacuum packaged samples after 28 days of storage. Packaging requirements the role of package for cured meat is to minimize light fading by preventing the entry of oxygen and loss of moisture. The spoilage due to growth of bacteria and yeast is expected to be reduced by freezing or refrigeration. The package must be able to withstand low storage temperature and also present an attractive appearance. The packaging material should be of good oxygen and water vapor barrier.

It should be flexible enough to make a close surface contact with meat. The packaging film should be capable of lamination or co extrusion and hermetical sealing. The over wrapping short term storage of cured meats can be done by over wrapping the product with polyethylene. Some other films like polyvinyl chloride, polyvinylidene chloride provides high tight fitting over wraps. Aluminum foil and paper laminate can protect the cured meats against light.

Another type of package called the chub pack is used for some ground products. Chub packs are tubes stuffed stuffed with soft products which is twist tied or clipped at each end as depicted in the picture. The packaging film used for chub pack is generally polyethylene. The shrink packaging ham and other large irregular cuts of meats are packed in shrinkable PVDC PVC copolymer films where the air is evacuated and the contour is over wrapped either by immersing a hot water of temperature 90 to 95 degree Celsius or passing through hot air tunnel to affect the shrink. Vacuum packaging for long term storage of bacon blocks luncheon meat etc vacuum packaging is the right choice.

This technique assures a shelf life of 5 months at 4 degree Celsius and 6 to 8 months at 18 degree Celsius. The following laminates are used for vacuum packaging. Cellophane PVDC LDPE polyester PVDC LDP polyamide PVDC LDP metallized polyamide ethylene vinyl acetate or ethylene vinyl acetate PVDC ethylene vinyl acetate polyamide LDP enomer PVDC PVDC PVDC LDP laminates are used for packaging sliced luncheon meat. In all the above cases plastics provide a wide range of packaging solutions. The factors which influence the form of microbial spoilage of the cured meats are two like for example, product characteristics and the environmental factors.

The product characteristics will include the nature of tissues that is the fat or lean etc the pH of tissue moisture content level of curing salt that is sodium chloride nitrite or nitrate smoke components polyphosphates sugars and other curing adjuncts. Then the environmental factors which include storage atmosphere that is the oxygen and carbon dioxide level the storage temperature and time and the heat treatment. All these factors they govern the form of microbial spoilage of cured meats. Most cooked meat are canned and have a long shelf life of over 2 years. Thermal processing is usually done above 100 degree Celsius by applying pressure.

Generally hermetically sealed rectangular tin plate containers with easy open devices are used. Meat products like patties, sausage, nuggets and meat balls are packaged in pouches made of polyethylene, polypropylene, PVDC rubber hydrochloride etcfor short term storage testing for 10 to 12 days at 4 degree Celsius temperature. Products like corned beef, corned pork, meat gravies, meat soups, liver sauces, chicken curry, boneless chicken etcetera are hermetically sealed and cooked to make commercially sterile for long term storage at room temperature. Metal containers are used for this purpose. Canned meat products are shelf stable for a number of years at room temperature.

Tin plate is mostly used to pack these products. They are coated on the inner side with sulphur resistant lacquer. Also drawn aluminum cans with internal lacquer are also used to pack some products. Thermo process meat in retort pouches are self stable for a

minimum period of 1 year. Meat film especially film foil film laminates are used in making the retort pouches are as follows.

The outer plastic film made up of polyester, polyamide or oriented polypropylene provides support and physical strength to the composite. The middle layer of aluminum foil contributes excellent barrier properties whereas, the inner layer consisting of polypropylene provides heat sealability. Now, the packaging of dehydrated meats. Dehydration is a successful means of preserving many meat products with proper packaging because they are highly susceptible to oxidation resulting in rancid odor.

The packaging materials used are tin plate cans. Metal foil plastic film laminates are used to pack compressed bars of dehydrated mince meat with inner cellophane and outer paper aluminum foil PE laminate. This pack is said to be self stable for 1 year. Flexible pouches suitable for vacuum and modified atmosphere packages made from polyester PE and aluminum foil PE or cellophane PE aluminum foil and PE laminates are also used. Thank you very much.