Moulds and fungus

Fungus usually grows well on unsalted and salted dried fish, which has high moisture, content. Moulds usually grow at relative humidity above 75 %. The optimum temperature for growth is 30 -35 degree C. In salted fish, brownish black or yellow brown spots are seen on the fleshy parts. This is mainly caused by growth of halophilic mould called Sporendonema epizoum. This gives the fish a very bad appearance.

During the initial stages of appearance of moulds on the fish, it is possible to remove them manually. In advanced stages when it has penetrated the flesh nothing can be done. To avoid the mould growth it is necessary that the fish be dried properly to pack the fish in required type of packaging material and keep it in a cool and dry place from moisture. Chemical method of prevention includes dipping the fish in a 5% solution of Calcium propionate in saturated brine for 3-5 minutes depending upon the size of the fish.

Rancidity

This is caused by the oxidation of fat, which is present in the fishes. Rancidity is more pronounced in oil rich fishes like mackerel, sardine etc. The unsaturated fat in the fish reacts with the oxygen in the atmosphere forming peroxides, which are further broken down into simple and odoriferous compounds like aldehydes, ketones and hydroxy acids, which impart the characteristic odors. At this stage the colour of the fish changes from yellowish to brown this is known as rust. This change results in an unpleasant flavour and odour to the product, thus leading to consumer rejection. Though a certain degree of rancidity can be accepted, it is seen that the nutritional value of these fishes are much lower than non-oxidized ones. These fatty fishes continue to become rancid during storage. Certain impurities in salt and traces of copper accelerate this.

Pink /Red Halophiles

This type of spoilage is mainly due to the presence of halophilic bacteria. The source of such bacteria the salt. It is commonly found in tropical countries like India. Spoilage appears on the surface as slimy pink patches. These bacteria are not harmful by nature. They are aerobic and proteolytic in nature, grows best at 36ºC by decomposing protein and giving out an ammoniacal odour.

Usage of good quality salt will avoid this. This spoilage is mostly found in heavily salted fish and absent in unsalted fish.

Insect Infestation

Spoilage due to insect infestation occurs

During initial drying stages

During storage of the dried samples.

The flies, which attack the fish during the initial drying stage are mainly blowflies belonging to the family Calliphoridae and Sarcophagidae. These flies are attracted by the smell of decaying matter and odours emitted from the deteriorating fishes. During the glut season when the fish is in plenty and some are left to rot, these flies come and lay their eggs. These eggs develop into maggots, which bury within the gill region and sand for protection from extreme heat. They develop mainly when conditions are favourable

with adequate moisture and intermittent rain. This results in both economic and nutritive loss to the fish processor.

Infestation can be reduced by:

Proper hygiene and sanitation

Disposal of wastes and decaying matter

Use of physical barriers like screens, covers for curing tanks etc

Use of heat to physically drive away the insects and kill them at 45ºC

The most commonly found pests during storage are beetles belonging to the family Dermestidae. Beetles attack when the moisture content is low and especially when the storage is for a long time. The commonly found beetles are Dermestes ater, D frischii, D maculates, D carnivorous and Necrobia rufipes. The larva does most of the damage by consuming dried flesh until the bones only remain.

Mites are also an important pest, which are found infesting dried and smoked products. They are very minute and bring about powdering of the product thereby giving it a white appearance. Lardoglyphus konoi is the commonly found mite in fish products

Fragmentation

Denaturation and excess drying of fish results in breaking down of the fish during handling. Fish can become brittle and liable to physical damage when handled roughly. It is necessary that fresh fish be used as raw material to ensure a good finished product.

Precautions to be taken before salting:

The fish used for salting should be as fresh as possible. It should be borne in mind that fresher the fish the better will be the end product.

The water used for washing and brining should be potable and should not be coloured or contaminated.

Salt used should be of good quality and should not contain high amounts of Magnesium and Calcium chlorides. These being hygroscopic in nature will delay the drying process.

While dressing the fish care should be taken to clean and wash the same. The intestine should not be ruptured since this will contaminate the flesh

All utensils and tanks used for drying and allied purposes should be cleaned properly and dried before use

Cement tanks should be scrubbed scrupulously and kept clean

Workers engaged in drying should be free of illness and should have an idea about handling practices

No waste should be left unattended; the waste should be disposed off properly.

Drying racks should be kept clean.

Some commercially important dried products

Beche-de-mer

Prepared from sea cucumber is an important item of export. This is made from Holothurians, which are boiled and dried. This is an important item for preparation of soups and also as an aphrodisiac in the orient.

Masmin

It is the most fish product of the Lakshwadeep islands. It is prepared from skipjack tuna. The meat is boiled in seawater and alternately dried and smoked till the characteristic flavour and colour is got. The finished product is a hard-smoked and hard dried one with a shelf life of more than a year.

Prawn Pulp

This was a important item of export in the earlier days. Now it is of lesser significance. Here the prawn is boiled with the shell on and the dried. The shell is removed by beating out on a hard surface. The pulp is separated and packed.

Shark Fins

The shark fins are a very highly priced commodity in the international trade. The fins yield gelatin fibres, which are used by the ethnic Chinese community for preparation of soups and other delicacies.

Fish Maws

These are swim bladders of certain fishes like eel, carp, catfishes, scianeids, polynemids etc. These are further processed to obtain isinglass, which is used in the clarification of wine and beverages.

Canning

Canning is a method of food preservation in which preservation is achieved by the destruction of micro-organisms by the application of heat. The use of an appropriate container for packing fish averts the possibility of re-entry of micro-organisms and further spoilage. Since the canned foods are sufficiently cooked products and free from micro-organisms they offer consumer safety besides being ready to consume. Canning has the unique distinction of being an invention in the field of food processing/ preservation whereas all other methods can be considered as adaptation of natural processes or their modifications. Because of their very long shelf life and ready to consume feature canned products have become very popular and a variety of food stuffs, both plant and animal origin and their combinations are produced and distributed. Canned products possess the following salient features.

Consumer safety: Canned foods are free from micro-organisms and protected against any further contamination

Ready to consume products: they are sufficiently cooked products and hence can be consumed without any further preparation

Canned foods are concentrated foods: Only the edible portion is packed after removing all waste parts

No special storage facility needed: Can be stored at ambient temperature

Very long storage life: Properly processed canned foods keep well for more than one year.

Processing methods are simple

The process can be applied to a wide variety of foods of both plant and animal origin

The process renders itself suitable for automation

The important operations involved in a canning process are:

Selection and preparation of raw material.

Pre-cooking / blanching

Filling in to containers.

Addition of liquid medium

Exhausting

Seaming

Heat Processing / Retorting

Cooling

Drying, warehousing, labelling and casing

The general steps involved in a canning process remain the same, but slight variations are introduced to suit a particular case.

Selection and preparation or raw material

A great variety of fish and shellfish suitable for canning are available in our country. Sardine, mackerel, tuna, seer fish and shellfishes like shrimp, clam, oyster, mussel, crab etc. are suitable for canning.

Raw material quality is very important for canning. Only fresh fish should be taken for canning. Since the heat processing is standardised with respect to a known level of microbial spore population, the number in excess will result in the failure of destruction of micro-organisms. Therefore, it is essential that, the bacterial load in the fish prior to canning should be kept as low as possible. This can be achieved by using very fresh fish, proper dressing and thorough washing in potable water and keeping properly iced.

Preparation of raw material include de-scaling, beheading, gutting, removal of fins, tail and cutting in to small pieces etc. In the case of shrimps, peeling and de-veining is done Bivalves like clams, mussels, oysters etc require a purification process called

'depuration` for improving the bacterial quality of the meat. The depuration technique is to subject the organisms to starvation for 18 to 24 hours in filtered water collected from the natural habitat and chlorinating the water lightly 2 hours prior to taking out the shell fishes. The shellfishes are then heated in open vats till their shells are opened. The meat is picked out or sieved and collected and thoroughly washed in potable water. In the case of crab, the legs, outer shell (carapace) body flap, gills etc. are removed and the body is split in to two or four pieces. The pieces are then thoroughly washed in potable water.

Blanching/Pre-cooking

i. Cold blanching

The dressed fish is subjected to this process before filling in to cans. The process is to keep the fish pieces immersed in a salt solution, the concentration and dipping time varies depending on the species and size of fish. This process removes blood, slime, dirt, etc and gives firmness to the texture and imparts a salty taste to the product. It also reduces the bacterial population.

ii. Hot blanching

For shell fish including shrimps and crabs, blanching process is done in boiling brine. During this process the shrimp meat gets their characteristic red colour, curls and shrinks in size permitting adequate filling in to cans.

Pre-cooking of fish is carried out in steam with or without pressure either before or after packing in to cans. The fish is cooked for such a length of time that no further water is exuded while the cans are subjected to heat processing. For sardine, the cooking time is found to depend on the fat content, lean fish taking larger cooking time. This process will expel the cellular gases and improve vacuum in the can, inactivate the enzymes and reduce the bacterial population.

Filling into containers

Widely used container is the tin plate can commonly known as the 'open top sanitary can` (OTS cans). The tin plate can is 98% steel and 2% tin coating on either side. (The can used for canning fish is internally coated with a sulphur resistant lacquer (SR lacquered cans) for preventing black discoloration in canned fish. The sulphur from the sulphur containing amino acids in the fish muscle reacts with iron in the tin can and forms black iron sulphide, which results in what is known as sulphide blackening. The tin coating applied to the can is expressed in grams per square metre (GSM). The two practices employed in tin coating are the Even coating and Differential coating. In Even coating, equal quantity of tin is deposited on both sides, e.g. E.5.6/ 5.6 indicates a coating weight of 5.6 GSM on either side of the tin sheet. When the coating thickness is different on both sides, it is called Differential coating, eg. D 11.2/5.6 indicates a tin coating weight of 11.2 GSM on inner side and 5.6 GSM on the external surface of the can.

The most commonly used lacquer in fish cans is the oleoresinous C- enamel lacquer. C-enamels contain Zinc oxide, which reacts with sulphur compounds producing zinc sulphide, which is white in colour. The colour of the product thus remains unaffected.

An ideal container is expected to possess the following features.

1. Strong enough to protect the contents during transportation and handling.

Light enough for economic handling

Should be impervious to air, moisture, dust and disease germs once the can is sealed air tight.

Pleasing and sanitary appearance

Internal lacquer should not impart toxicity to the contents

Should withstand the sterilisation pressure and temperature

Inexpensive, preferably cheap enough to discard after use

Capable of sealing at high speed.

The OTS cans meet most of these requirements and hence it is widely used in the food industry. One practical difficulty met with OTS can is in opening the can. Tin cans with easy opening lids (EOE cans), Aluminium cans with EOE facility etc. are the innovations in this direction for easy opening.

Addition of liquid medium

The liquid medium besides serving as a constituent of the product and improving taste, texture, flavour, it also facilitates rapid heat penetration enhancing the sterilisation process. Brine is the most satisfactory liquid medium for most fatty-fishes where as non-fatty fishes require special additives to improve their flavour and texture.

Oil, usually double refined and de-odourised vegetable oil, is the principal additive for many canned fish products. The oil used should be such that it should not undergo any change during heat processing. It also should not impart any colour or flavour to the product.

Tomato sauce is an important additive in mackerel, oyster and the like. The tomato sauce for use as packing medium should be prepared out of good quality tomato and the colour of the sauce should not deteriorate during heat processing. The consistency *of* the sauce should be adjusted to a solid content of 28 to 30%.

There are a number of other additives such as carboxy methyl cellulose (CMC}, monosodium glutamate (MSG}, sugar, vegetables, spices etc. added in specific cases to yield canned products of specific qualities. While filling with liquid medium a head space of 6 to 9 mm from top of the can should be provided for adequate vacuum formation in the can.

Exhausting

Exhausting is the process of removal of air from the contents and headspace of the can before it is seamed. This is a very important operation and has the following functions to perform.

Minimises the strain on the seams through expansion of air during heat processing.

Removes oxygen and eliminates the chances of can corrosion.

Ensures proper vacuum. During exhausting the air in the can is replaced by steam which on cooling creates vacuum. Certain amount of vacuum in the can is a product quality criterion.

Oxidation of fat and consequent deterioration in quality is prevented.

Vitamin C- is preserved

Exhausting is achieved by one of the following three methods.

Seaming

The objective of sealing is to provide an air tight seal between the can body and the can end (lid) so that micro-organisms cannot gain entry in to the cans. Perfect sealing is a critical operation stage in a canning process. For providing perfect sealing to the can adjustments to the seaming machine are done before starting the seaming operations and the double seam formed is examined with standard measurements. The sealed cans are also subjected to pressure testing for checking the seam perfection. The can seaming machine should be checked daily for its performance before the cans are taken for sealing.

For providing a hermetic sealing a rubber sealing compound is applied to the groove (curl) of the can end. The successive operations of the first and second rollers of the seaming machine gives the double seam, the perfectness of which should be checked as per the guidelines given by the manufacturer.

The exhausted cans are sealed without any delay. The delay may cause cooling of the contents and air may occupy the headspace thereby leaving no room for vacuum formation.

The sealed cans are washed using a detergent. The adhering meat particles, grease or oil from the sealing machine etc are washed before taken for the next operation.

Heat Processing

Heat processing is the most important operation in canning process. In heat processing/ the product is subjected to heat at a high temperature (say 110°C or above) to sufficient length of time to cause destruction of all pathogenic organisms and inactivate or destroy the micro-organisms causing. Among the pathogenic bacteria, *Clostridium botulinum* is the most important, since it is able to grow in sealed cans under vacuum if it present and lead to the development of a potentially lethal toxin. In general, proper thermal processing prevents spoilage, helps to retain most of the organoleptic qualities and assures consumer safety.

The temperature and duration of heat processing depend on the type and nature of micro organism and heat penetration characteristic of the food.

When micro-organisms are subjected to heating in steam, it is observed that 90% of the population is destroyed at equal intervals of time at a particular temperature. This time to reduce the bacterial population by 90% is known as the 'D' value or the decimal reduction time at that temperature. The 'D' value is in fact, a measure of the heat resistance of the micro-organisms. Safety from botulism, is assured by giving a process equivalent to 12 decimal reductions (12D) in the population of *Cl.botulinum..* This is made more reliable and reasonable by assuming an initial *clostridium botulinum* spore level of 1 organism per gram of the food material by reducing the spore level to 10-12.

In the case of non-pathogenic spore, a comparatively higher initial spore level and final spore survival is accepted on grounds that health risk and spoilage is not so severe as compared to that of C*l.botulinum..* If a very low spore survival in the case of non-pathogenic thermophilic organisms such as 10-12 is considered, it will require heat processing for longer periods leading to unfavourable situations, like loss of quality, increase in energy consumption, decrease in production output etc. Hence a compromise on heat processing time for obtaining safety from C*lostridium botulinum* and non-spoilage due to thermophilic non-pathogenic organisms is an acceptable practice. The sterility condition arrived on this concept is known as commercial sterility. In relation to canned foods, FAO/WHO Codex Alimentarius Commission (1983), defines commercial sterility as the condition achieved by the application of heat, sufficient alone, or in combination with other appropriate treatments, to render the food free from micro-organisms capable of growing in the food at normal, non- refrigerated conditions at which the food is likely to be held during distribution and storage.

The cans are stacked in crates and placed in retorts for heat processing. Before closing the lid of the retort, air from the retort is completely fleshed out by flushing with steam. The air vent is then closed and steam is admitted in to the retort in such away that the temperature and pressure is raised slowly till the required temperature and pressure is attained. Heat processing is carried out at the designated temperature, pressure and duration till the heat processing value designated as F_0 is attained. F0 value is the heat processing time at 121°C (250°C). In practice, the lethal rates of all temperatures above 90°C is integrated in terms of heating at 1210C and the total lethal rates of the heating process is expressed as equivalent to heating at 121°C. When the heat processing is over steam is released slowly till the pressure is brought down to zero. Aluminium cans and flexible pouches require super imposed pressure cooling for preventing bursting while steam pressure is released. The cans are taken out and transferred to cooling tanks immediately after heat processing.

Cooling

The heat from the can as well as the pressure developed inside the can has to be reduced rapidly for preventing straining on the seam and excessive cooking. The seam in a heated can is in an expanded condition. There can be microscopic openings in a seam through which cooling water may be sucked in. If this water is contaminated, it will lead to spoilage of the cans. This calls for maintaining proper water quality .The cooling water must be of potable quality chlorinated to an available chlorine of 5 ppm. Continuous use of the same water for cooling helps in building up bacterial load, particularly in later stages when there will be ample nutrients in cooling water in the form of fish particles washed off from can exterior. The cans must be cooled to 37°C retaining sufficient heat for drying the can surface which also protects against rusting.

Drying, warehousing, labelling and casing

The processed cans must not be cased hot because the loss of heat by radiation from the cases will become slow which will provide favourable condition for the development of thermophilic bacteria which might have survived heat processing. Cans should not be stored adjacent to steam pipes or humid environments. Warehouses should be away from chemical and fertiliser factories where the fumes of chemicals/fertilisers are harmful to food cans. Warehouses should be clean, cool and dry. Water condensing on surface, high humidity or temperature, corrosive fumes etc. leads to rusting of the cans

Battered and breaded products

Battered and breaded seafood offers a convenience food valued widely by the consumer. Battered and breaded items are included in the value added products because the

process of coating with batter and breadcrumbs increases the bulk of the product thereby reducing the cost element. The pick up of coating on any product can be increased either by adjusting the viscosity of batter or by repeating the process of battering and breading. As a convention 50% fish portion is expected in any coated product. Fish fingers, fish portions, fish cakes etc. are the staple breaded seafood lines, while breaded shrimp, lobster, oyster, scallops etc. cater to a luxury market are widely used in restaurant trade. The production of battered and breaded fish products involves several stages. The method varies with the type of products and pickup desired. In most cases it involves seven steps. They are portioning/forming, pre-dusting, battering, breading, pre-frying, freezing and, packaging and cold storage.

Portoining/forming

Portioning is an important stage in the production of coated fishery products. Cutting loss and surface area of the portions are the two important points which determine the economics of coated products. Key factors in the product of fish portions are the speed and accuracy with which the frozen fish blocks can be processed at minimum cost.

A recent innovation for the catering sector is forming of skinless and boneless fish fillets into a predetermined shape and size using specially designed forming machines. The shapes vary from conventional fillet shapes to several other imaginative ones.

Pre-dusting

The purpose of pre-dusting is to prepare the surface of the portion so that batter can adhere uniformly. Pre-dusting also improves the adhesion of batters to frozen or greasy food surfaces. Pre-dust normally consists of a very fine raw flour type material. A more sophisticated and expensive pre-dust may contain spices and seasonings for both functional and flavouring purposes.

Application of the batter

Conventional batters are of low to medium viscosity and hence can be applied with total submersion or overflow batter applicators. Low viscosity batters are normally applied in an overflow configuration. Medium viscosity batters may require a total submersion system depending on the product requirements.

The pre-dusted product is conveyed to the batter applicator and transferred to the next conveyor, which will draw it through the batter. The fish portion is totally submersed in the batter as it is drawn through it. Other applicators may use a pour-on application in addition to the submersion method. Irregular shaped products should be placed on the line with any concave surface upward to prevent air pockets from inhibiting batter pickup.

Application of breadings

There are many types of breading applicators available and the appropriate machine depends on the ingredients used. The speed of the breading machine is so adjusted to closely match the belt speed of the batter applicator.

For soft products the crumb depth should be maintained as thin as possible to avoid product damage when leaving the breading machine; however, frozen or hard products should have a deep bed of crumbs. Pressure rollers are used to apply sufficient force to press crumbs onto the battered product.

Pre-frying

After coating with batter/bread crumbs many products are often flash fried prior to freezing. The purpose of pre-frying is primarily to set the batter/bread coating on the fish portion. Flash frying develops a characteristics crust and gives the product a characteristic fried (oily) appearance and taste. Therefore the temperature of frying oil and the time of frying are critical. The normal frying temperature is between 180-190 °C and the frying time 20-30 seconds. The term pre-frying is used because the final product frying is completed by the consumer. The battered/breaded fish portions enter the frying medium through a conveyor system, the speed of which is adjusted so as to keep the fish portion in the hot vegetable oil for the required time.

Freezing

The fish portion leaves the frying oil with a coating temperature equivalent to that of the oil but still frozen in its center. Although the fish flesh center is frozen the surface flesh may be partially thawed. Therefore a quick and efficient freezing method is very essential to keep the quality of the coated product.

The first step in preparing the fried fish portion for freezing is air cooling. This is usually accomplished with the use of a fan or a series of fans. This allows the coating temperature to drop, while at the same time allowing the batter coating to recover from the frying shock and also to stabilise itself. The coated fish portions are then fed to the freezer through conveyor belts. Freezing is usually carried out in spiral freezers. Freezing is completed when the internal and external temperature of the fish portion drop to about -10°C.

Packaging and storage

Most of the battered and breaded products like fish fingers or portions are individually packed into small boxes on a weight basis or by a specified number of pieces. When individually packed, layers of the product will be separated by a waxed paper to prevent further product damage. The boxes are labeled and over wrapped with a polythene film to prevent moisture loss and freezer burn during storage. The packed boxes are stored at around -20 0 C until shipped.

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