Package Designing for Thermally Processed Foods and Beverages: A Review

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Abstract: ***There has been many innovative preservation methods that have been recently introduced in food technology including high pressure processing, irradiation, ozoning, etc. However, still the most extensively used method for food preservation is the conventional thermal processing of foods i.e. use of high temperatures for processing or preservation (by heat destruction of spoilage microorganisms, ex wild yeasts, Acetobacteracetii, etcand pathogenic microorganisms ex Clostridium botulinum , Coxiellabernetii, etcand spoilage enzymes ex poly phenol oxidases, peroxidases, etc) of foods and beverages which includes pasteurization, appertisation (or canning), baking, microwaving among many others. Packaging mainly provides protection and preservation to the food material and also does the function of promoting the food product by displaying information about it for customer/ consumer reference. Therefore it becomes essential to focus on the designing, properties, availability, safety etc of packaging material to be used for thermally processed foods and beverages. The review focuses on the basic types, requirements, and properties of thermally processed foods, the outline of the processing operations involved and mainly on the types, materials used, properties, designing, handling, costing, suitability, safety usage, and recent developments in the packaging of thermally processed foods and beverages.***

Keywords: preservation, thermal, packaging, pathogens

1. Introduction

Packaging of materials is a combination of art and science [1]. Packaging has become a necessity for almost every kind of food. There has been revolutionary changes in the field of packaging with the development in science and technology. A few decades ago, for buying provisions common people had to carry with them bottles, or some other containers, gunny bags etc[1]. However, nowadays properly packed items are available in all stores and groceries. In fact, they have almost completely replaced the old system. Packaging protects the food material from climatic (oxygen, light, heat, moisture, and microorganisms) and mechanical (compressions, vibrations and impact forces) hazards [1]. Packaging enhances the shelf life of the food product. It also promotes the product and attracts people to the product by being a silent salesman [1]. It also adds to the convenience of product handling to the transporters, distributers, customers and consumers. There are a number of packaging materials that are used for their desired function for different types of food products. Most commonly used packaging materials are paper, paperboard and plastics [2]. Metal and glass are also commonly used for numerous liquid and semi-liquid food products [2]. The appropriate selection of the packaging material to be used for a particular food is essential for assurance of the safety and quality of the food product. Thermally processing of foods includes blanching, pasteurisation, commercial sterilization, etc. Use of heat for the destruction of spoilage enzymes and microbes, pathogens, is the basis for thermal preservation[3]. The basic requirement of the packaging material to be used for thermally processed foods is that it must resist high temperatures and mild pressure without interacting with food product and also without reducing its barrier properties [4]. This is essential for maintaining safety and quality of food products.

Heat processing:
Of all the various methods used for processing and preservation of foods, thermal methods occupy the highest spot. The microorganisms are destroyed by heat due to the inactivation of the enzymes required for their metabolism. The type and the intensity of heat treatment used depends on the kind of microorganisms needed to be destroyed, and if the additional preservative methods are applied or not [5]. Most types of microbes have their optimal temperature of growth between 16°C-38°C (mesophiles), and their growth generally stops below 5°C and above 45°C [6]. Some microorganisms grows best at high temperature ranging between 66°C-82°C (thermophiles) [6]. Most of the bacteria are destroyed in the temperature range of 82°C-93°C, but their spores and some heat-resistant forms can even withstand higher temperatures about 100°C even for prolonged period of exposure [6]. However these are destroyed in wet heat at 100°C in about 15 minutes [6]. The death of microbes by heated dry air is due to oxidation, therefore a higher temperature is required for killing whereas, in case of moist heat, the death of microbial cell is due to coagulation (reaction of proteins with water), which is accelerated many folds by raised temperatures [6]. The complete destruction of microbes is known as sterilization, which is achieved at temperature of 121°C wet heat for 15 minutes. However, such harsh treatment may result is destruction of desirable food properties. Therefore, comparatively mild temperatures are used, leading to varying shelf life of different products depending upon the heat treatment used and final storage conditions.

Factors affecting resistance of microbes to high temperatures:
1) Time and Temperature: More is the temperature, less time will be required for the destruction of microbes. Lower temperatures will require more time.
2) The types of microbes present: Thermophiles will require comparatively highest temperatures, then mesophiles and lowest will be required by psychrophiles. Gram positive bacteria are more resistant than Gram negative varieties.
3) Number of microorganisms initially present: The higher the count, more is the resistance due to higher

production of protective substances or protein extracellular component [7]. Also more varieties of microorganisms will be present with different heat resistances.

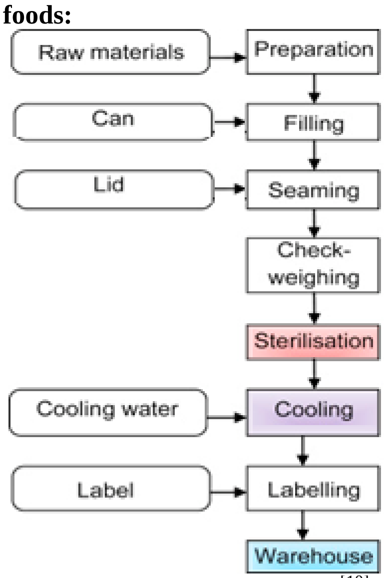
4) Initial count of spores: More spores means higher time or temperature required for destruction.
5) Desiccation of spores: Dried spores are more heat resistant than the moist spores [5].
6) Food ingredient/ medium/ substrate: Constituents of food like water, sugar, salt, and colloidal constituents affect heat resistance [5]. For ex a microorganism in food with a high fat content has more resistance due to fat protection. Also long chain fatty acids provide more protection to the microbes than the short chain [7]. Microorganisms with high proteins have more resistance, as proteins are colloids, which provides protection to microbes [7].
7) Phase of growth of microorganisms: Lag phase constitutes greatest resistance, whereas logarithmic phase has least resistance. Young spores are less resistant than mature ones [5].
8) Previous history: The initial conditions in which the microbes or spores have been grown affects their resistance. In general, microbes from better culture medium shows more heat resistance [5].
9) Temperature of incubation: Higher the incubation temperature, more will be the heat resistance [5].
10) pH: It is the most important factor. In general, high or low pHwill reduce the heat resistance and neutral pH will increase the resistance [5]. However, acidic pH will be more effective in destruction than an alkaline pH [5]. Therefore, acidic foods are heated for lower time temperature combinations than neutral or alkaline foods.

Factors affecting the rate of heat penetration:

It is essential to measure the rate of heat penetration at the slowest heating point also called the cold point of a container in order to establish or standardise a process for any particular product [5]. This cold point is generally the geometric centre of the package in which heating is done by conduction and a little below the geometric centre is the cold point when heating is done by convection [5]. Various methods, procedures and equipment may be used for collecting the accurate heat-penetration data [8]. These time-temperature data varies from product to product because of numerous factors:

1) Product: Size and shape of the product affects heating. Large pieces take more time to cook. More the consistency, greater time to heat [5]. Blanching loosens the tissues thus reducing time for heating [9]. Product matting or clumping may also result in change in heating. Stacking of sliced products may also cause variations [8]. Additional product properties including salt content, water content, pH, specific gravity, concentration of preservatives may also influence the heating rate [9].
2) Container: The material of container (glass jars, metal cans, retort pouches, semi-rigid containers) and dimensions affects the heat penetration rate [8]. Heat penetration through glass takes longer time than in metal cans and larger cans heat slowly than the smaller ones [5]. More the thickness of packaging material lower will be the heating rate. Changes in the container orientation (horizontal or vertical) may also affect the rate [8].
3) Rotation and agitation: They increase the heating rate. However, they may cause some undesirable physical changes [5].
4) Other factors include the amount of headspace left and the stacking of the containers over each other in the retorts [5].

Canning of foods:



Basic food canning operation [10]

Canning was invented in 1810 by a Paris confectioner and distiller, Nicholas Appert and thus in his honour canning is also known as appertisation[11]. The principle of canning is to bring every particle of food inside the can to a sufficiently high temperature and holding at that temperature for a specified time to destroy the pathogenic and spoilage microorganisms [13]. Many foods and beverages are canned including fruits and vegetables, meat and meat products, fish and fish products, juices, syrups, etc.

Packaging materials for canning:

Glass jars:

Initially, when canning was discovered, it was done in glass containers exclusively. Glass containers are made by heating a mixture of silica, sodium carbonate, calcium carbonate and alumina to high temperatures which is then poured onto moulds] [14]. The glass containers used in packaging of foods are generally surface-coated to provide lubrication in the production line and to remove surface scratching or abrasion and line jams [14]. Glass is odourless and chemically inert and thus do not interact with foods, provides good insulating properties and can also withstand high processing temperatures thus, is suitable for canning [14]. The transparency of the glass containers allows the consumers to see the product, yet the variations in the colour of the glass container protects the inner contents from light [14]. Also, glass is reusable and recyclable thus is also beneficial for environment [13]. However, glass has disadvantages like it is heavy thus increases handling and transportation costs, it is brittle and thus is susceptible to breakage from internal pressure, impact, or thermal shock [14]. Therefore they are not very common [17]. Common food products canned in glass containers are pickles, olives, fruits, syrups, meat products, sauces, juices, etc[15].

Metal cans:
Metal cans were initially introduced in the beginning of the 19th century, specifically for the packaging of wine, but its application has now expanded widely especially in the canning of numerous foods and beverages [16]. Metal cans are generally made up of steel, aluminium, and tin [16]. Metal cans can be two-pieced or three-pieced. Metal is most versatile of all the packaging materials available [14]. It provides excellent physical protection, barrier properties, formability, decorative potential, recyclability, easy printing and consumer acceptance [14]. Various food products canned in metal containers are beer and soft drinks, yogurts, butter, fruits and vegetables, sauces, etc[18].

Aluminium: As a packaging material, Aluminium has many desirable qualities such as lightness, ductility, high thermal conductivity, gloss and impermeability to gases, water vapour and light [19]. However, Aluminium is expensive due to high cost of electrolytic process which is required for obtaining aluminium metal from raw material [19]. The use of aluminium for canning is limited to the packaging of beer and carbonated beverages, for which aluminium alloys with variable concentrations of magnesium (up to 5%), manganese (up to 1.5%), and traces of other elements like iron, copper, zinc, silica, etc., are being used [19]. Pure aluminium is not used in acid foods as it is susceptible to corrosion to attack by acids [18]. This leads to its dissolution and uptake by the food stored inside the can. High concentrations of salt (more than 3.5%) can also increase the rate of migration, because of this aluminium is generally coated for packaging[18].

Tinplate: Tinplate is a light-gauge, cold-reduced low-carbon steel sheet or strip, which on both the faces (inner and outer) is coated by commercially pure tin [20]. Thus, it combines the strength and formability of steel with the corrosion resistance, solderability and good lusturous appearance of tin [20]. Tinplate is widely used for canning of foods and beverages. Tinplate is basically a steel product, coated with tin on both the surfaces [19]. Therefore, manufacture of tin plate happens in two steps. First, is the manufacture of steel sheet or strip of desirable dimensions and composition based on the final use and second is coating with tin to a desired thickness [20]. The steel base used for tinplate manufacture is a low carbon mild steel typically containing 0.003-0.12%carbon [20]. Tin is nowadays exclusively coated on the steel base by electroplating in a continuous process [20]. Initially, hot-dipping in tin was done, but it produced somewhat non-uniform coat and less control of the process along with higher cost. A typical thickness of coating is in the range of 0.1-1.5 microns depending upon the end use of the tinplate[20].

Corrosion of tinplate and dissolution of tin into the canned foods:

The main disadvantage of tinplate is its corrosion over time. Tin is regarded as a priority contaminant by the Codex Alimentarious Commission[21]. Tin can enter foods from environmental pollution, pesticides, packaging material, etc. Higher concentrations are found in canned foods if not taken care [21]. Dissolution of tinplate into foods depends on the acidity, presence of oxidising substances, presence of air or oxygen and storage time and temperature [21]. Corrosion is usually caused by air particles getting into the tiny pores of the respective metals [21]. Corrosion can be internal which largely depends on the composition, acidity of contents, presence of air and oxidative substances, and external which may be caused due to external environment, water or steam exposure, use of corrosive glue, improper handling, etc[21]. Corrosion can be prevented by using electrogalvanised cold-rolled steel, fully sealing enclosures, painting treatments, powder coating, etc. The most widely used method however is coating with a lacquer [21].

Lacquering of tinplate:
The interior surfaces of tin cans are typically coated with polymeric lacquers for preventing corrosion of tin by the contents of the can. The lacquer may also provide lubricating properties to the cans improving its aesthetic and manufacturing properties [22]. The lacquer used should be corrosion resistance, flexible, abrasion resistance, non-toxic and should have good adhesion [22]. Since lacquering is typically done before rolling of tinplate into cans therefore, lacquers should be able to retain its integrity during the can forming process [22]. Several types of lacquers are available commercially, chosen to suit the can contents.

1) Oleoresins: The very first can coatings were made up of oleoresins, which are a mixture of oil and resins which are extracted from plants or synthetically made [23]. Oleoresins are flexible and can be applied easily, but they do not adhere well to the metal surfaces, have a limited corrosion resistance, needs long time for curing and may also affect the organoleptic properties of food materials [23]. Originally, linseed and castor oil were main oil constituents which were reacted with natural or synthetic resins [22].
2) Phenolic resins: Phenolic resins constitutes phenols and aldehydes and are highly resistant to corrosion and protect cans mainly from sulphide staining [23]. They are less flexible and do not adhere properly to the metal surfaces, and thus may change the organoleptic properties of the foods [23]. Unblended phenolic resins are not used in food or beverage cans [23]. It is applied in low coating thickness [22].
3) Vinyl coatings: They are synthesised from vinyl acetate and vinyl chloride. They have good flexibility and are stable under low and high pH but they do not properly adhere to the metal surface and are also less heat resistant [23]. These cannot be used alone and require plasticizers and stabilizers and are often blended with other resins [23].
4) Organosol: Vinyl organosols are made from blending suspensions of vinyl resin inorganic solvent [23]. Organosols offer comparatively more chemical resistance, thermal stability, and better adhesion properties than vinyl resin coatings [23].
5) Acrylic resins: They are commonly synthesized from ethylacrylate[23]. They have clear appearance and have good corrosion and sulphide resistance, but are brittle

abd thus may affect organoleptic properties of the food contents [23].

6) Epoxy coatings: They were introduced in 1950s, as coatings for aluminium and steel cans [23]. They are stable, has good protective and technical properties thus are used very commonly [23]. Most of the epoxy coatings are synthesized from bisphenol A and epichlorohydrin forming bisphenol A-diglycidal ether epoxy resins [23].
7) Epoxy-phenolic: It is the most widely used lacquer because of its excellent chemical resistance [22]. The ratio of epoxide to phenol can be varied from 5:1 to 1:1 depending upon the properties required [22].
8) Polyester: Carboxylic acids, Isophthalic acid (IPA) and terephthalic acid (TPA) are mainly used in polyester coatings [22]. They are easy to handle and adhere well to the metal, but are usually unstable in acidic conditions and have a poor resistance to corrosion [23].
9) Polyolefins: These coatings are very recent in the market [23]. They offer good corrosion resistance, adhesion and flexibility and also do not affect food flavour [23].

Tin Free Steel Cans: It is an electrolytic plated steel consisting of a thin layer of chromium and chromium oxide on a steel base, and provides it with a beautiful, lustrous metallic finish on both surfaces [19]. It is also known as electrolytic chromium coated steel (ECCS) [19]. TFS offers excellent resistance to corrosion, lacquer adhesion as well as printability [19]. However, it is not suitable for soldering and can only be used for welding [19]. It should be lacquered on both surfaces [19]. It is economic and is widely used for beverage cans [19].

Retort pouches:

It is a flexible pouch or container which is capable of withstanding high temperatures of retorting or autoclaving (about 120°C) [1]. These retortable flexible pouches may be manufactured from the combinations- PET/ adhesive/ aluminium foil primer/ adhesive/PP [1].Typical materials used are- 2-ply laminate: 12µm nylon or polyester/70µm polyolefin; 3-ply laminate: 12µm polyester/9-12µm polyolefin; 4-ply laminate: 12µm polyester/ 9-12µm aluminium foil/12µm polyester/ 70µm polyolefin [5]. All of these combinations are capable of producing microbiologically stable packages [5]. They can be used for retorting of frankfurters in brine, ready-to-eat meat dishes sausage mixes, etc[17]. The flexible retort pouches have various advantages over rigid cans such as shorter time period for sterilization due to thinner cross-section which leads to better quality of product and prevents overcooking, the shelf life of foods in flexible retort pouches is equivalent or more than that in rigid ones, the problem of product-container interaction is less than cans, vacuum sealing of contents without brine or syrup can also be done, weight is less, therefore, transportation and handling is better and more economic, it is easy to tear or open for usage [5]. However, retort pouches are not much used due to the problem of slow-filling and closing speeds as compared to rigid cans and also they need to be protected against wear and tear during distribution [5].

High-barrier plastics packaging:

High barrier plastics are those plastic packaging materials whose permeability is low enough to significantly prolong the shelf life of food products. It has application in wide range of food products and beverages and current market for it is very high [5]. Barrier packaging are so designed to keep moisture, oxygen, carbon dioxide, out of the packaging material to preserve the flavour, colour, odour, nutrients, and freshness of the food products and thus extending their shelf life. Barrier resins include ethylene-vinyl alcohol (EVOH) copolymer, polyvinylidene chloride (PVDC), polyamide or nylon (PA), cyclic olefin (COC), copolymer, cyclodextrin (CD), MXDX and others [24]. High barrier plastic packages generally used in thermally processed foods are:

Ethylene Vinyl Alcohol (EVOH) Coploymer: EVOH resins are non-toxic therefore can be used in direct contacts with foods and for high temperature lamination used in meat and cheese packaging [24]. It is excellent for packaging of oils and oily foods [24].

Polyvinylidene Chloride (PVDC): This film is clear and has good strength, and is heat sealable at low temperatures (120°C- 150°C) [24]. They have high resistance to hot oils [24].

Polyamide/ Nylon: It has excellent gas barrier properties, heat and grease resistance and are used for products such as meats, cheese and edible oils [24].

Metal Oxide Coated (MOC) AND Silicon Coated films: These are environmental friendly and transparent barrier films [24]. These are available in many combinations. Retortable high barrier plastic film in which aluminium oxide is deposited on PET is of retort grade [24].

Stepcan:

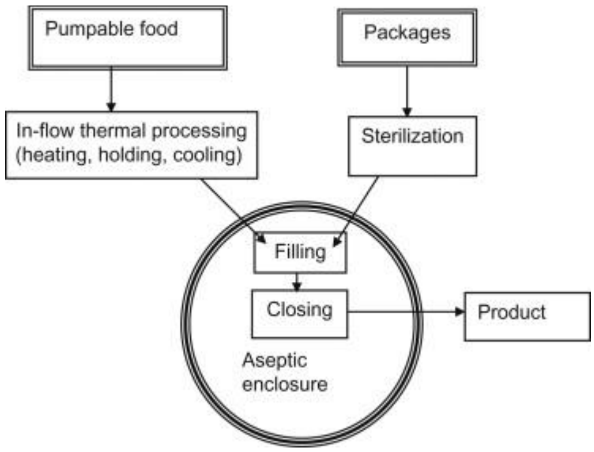
Stepcan is a combination of a plastic body of high molecular weight homopolymer PET with the conventional metal ends and it is filled, closed and processed on standard canning lines [5]. STEP stands for stretch tube extrusion process [5]. Extruded plastic tube is blown and stretched into an extended thin-walled ‘bubble’, which is cut into suitable lengths for heat treatment, after which they are further cut into individual container bodies [5]. One metal end is seamed on before filling by the container making and the packer seams the second end after filling [5].

Letpack:

Letpack was introduced in early 1978 by a Swedish company [5]. Letpack is a 3-pieced can with an extruded body made from a laminate of polypropylene on both sides of aluminium foil, which provides water vapour and gas barrier [5]. The body provides a good printing surface [5]. The ends are injection moulded and are lined with the same laminate which is used in the body and no tools are required to open the lid [5]. Different sized cans are made according to the requirements and suitability. The material that is used is retortable and suitable for contact with the food contents [5]. Processing can be carried out in the same way as the normal cans with a maximum recommended temperature of 130°C [5]. However they were not much accepted as early samples tended to split if they were dropped [5].

Aseptic processing:

Aseptic processing can be defined as the processing and packaging of any commercially sterilized product into presterilized containers which is followed by hermetic sealing with a sterilized closure in proper manner which will prevent the recontamination of the sterilized product by viable microorganisms [26].



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Aseptic packaging thus provides a better use of packaging system, as compared to the conventional canning methods by causing less thermal damage to the product and less stress to the packaging material [5]. Aseptic canning can be done by sterilizing the foods and cans separately and then aseptically filling is done [26].

Types of Aseptic Packs:

Carton boxes, bags, pouches, cups, trays, bottles, jars, metal cans, and composite cans can be used for aseptic packaging [27].

Tetrapack aseptic cartons: They are made of three basic materials which reaults into a safe and light-weight package with each component providing a specific function [27]. The product can be kept for months without refrigeration [27].

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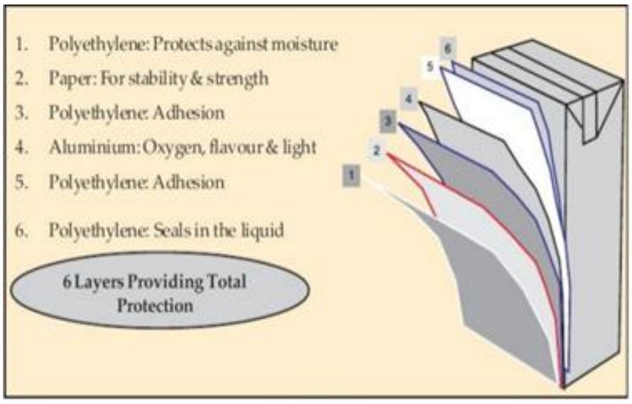

Composition of Tetra Pak Aseptic Cartons

In the Tetra range the packaging material is fed into the filling machine from a reel which is then passed through hydrogen peroxide bath, additional hydrogen peroxide is removed by squeeze rollersleaving a thin film of hydrogen peroxide on the surface [5]. Then it passes through the bending rollers from which it travels downwards and forms a tube which is sealed longitudinally [5]. Sterile air is constantly emitted into the area above the product level to prevent re contamination, while the transverse seams are being produced in the tube by a pair of jaws simultaneously pulling down the packaging material [5]. After longitudinal sealing, the tube passes a heater which heats the inside of the tube to 110°C-120°C [5]. Heating causes hydrogen peroxide to evaporate into oxygen and waterand the packaging material becomes sterilized [5]. The product is filled into these sterilized tubes or packaging material and sealing is done transversally below the level of the liquid by heat which melts the aluminium foil, which in turnmelts the sorrounding plastic and the area is sealed completely by applying pressure [5]. This package is then cut free from its neighbouring units and the passes to a final folding unit which gives it its final brick shape [5].

Sous vide:

The term sous vide means ‘under vacuum’ [5]. It is a method of cooking in which raw food material is heated or cooked inside vacuum pouches under controlled environment [28]. The foods are cooked in heat stable pouches or thermoformed trays which are sealed, so that natural flavor, aroma and nutrient quality is retained [5]. The common cooking temperatures for meats like pork, beef or lamb is recommended 58-63°C for 10-48 hours [28]. Sous vide is typically performed either as straight away serve immediately after cooking or as cook-chill in which the food should be immidiately chilled to temperatures of 0-3°C [28]. The sous vide method is generally used in top-end restaurants [28]. The packaging materials used in sous vide processing must be able to withstand the pasteurization and chilling temperatures and should also maintain the product integrity and quality [5].

Microwave processing of foods:

Microvave processing of foods has become an important part of the food processing technology. It has very wide applications in food processing such as in cooking, pasteurisation, drying, sterilization, thawing, cooking ready-to-eat meals, baking, tempering and preservation of foods [31]. Microwave processing has gained so much popularity in recent times due to its ability of achieving high heating rates, and thus significant reduction in cooking time, uniform heating, ease of operation and maintainance and safe handling [29]. Microwaves are EM waves having high feruency within range of 300MHz-300GHz [31]. The domestic microwave operates at a frequency of 915MHz and 2.45GHz [30]. Microwave heating of foods is because of the rotation/ vibration of dipolar molecules like water because of the highly oscillating electric fields because of which friction is created resulting into heat generation. The foods processed in microwaves are safe for consumption as the microwaves are converted into heat energy as soon as they are taken up by the food material and the food does not turn radioactive or contaminated [30].

Packaging materials for microwave processing of foods:

Three category of packaging materials are used for microwavable foods that are- microwave passive, microwave active abd microwave reflective [5].

Microwave Passive materials:

These are the materials which are transparent to the micowaves i.e., they do not heat directly by microwaves but allow the microwave energy to be absorbed by foods and allow them to heat [5]. Following are the main types of microwave passive materials used:

Glass: Glass is almost completely transparent to the microwaves and also provides excellent visibility and barrier properties [32]. The drawbacks are its heavy weight, fragility and relatively higher cost [32]. There are also chances of explosive boiling and ejection of high viscous foods , since most of the glass jars or containers are in the shape of verticle cylinderss, and there is a difference in the pressure at the top and bottom, and when heating is localised, and boiling occurs, the gases formed and are unable to make their way to the surface resulting in building up of pressure and ejection of some food material [32].

Paper and Paperboard: Paper and paperboard that are uncoated are only used for cheap vending applications because of low shelf life required, lower heating cycles and low costs and only precooked foods are heated to lower temperatures for immediate serving [32].

Film structures: Coextrusions or laminations containingsealant layers of medium density polyethylene (MDPE), whose melting point is more than the boiling point of water can be made into flexible structure packaging such as boil-in-bag, which generally contains frozen vegetables, vegetables with sauce, rice and other side dishes [31]. However, they do not provide proper barrier properties and require aluminium foil laminate for providing barrier, which should be removed prior to heating [31].

Plastic-coated paper or paperboard: This combines the rigidity of the fiber component and the chemical resistance and sealability of the polymer [31]. LDPE coated paperboard can be used for heating products below 100°C ex frozen vegetables [31]. Polypropylene can be used for a higher temperature ranges due to its higher melting point, has better grease resistance than LDPE [31].HDPE coating can produce even better temperature and grease resistance, but it is costly and has low sealability [31]. PET coating provides good temperature resistance and sealability but has limited gas barrier properties [31].

Polymer trays: Thermoformed polymer trays are widely used for microwaving foods, as complex shapes like multiple compartments, raised bottom etc can be made [31]. Various polymers and their combinations can be used depending upon the level of rigidity required [31].

Microwave active materials

Active package is the package that functions more than just containing the food material [31]. The use of only passive packaging produces unsatisfactory cooking results like sogginess or loss or cryspiness, lack of browning or colour development, localized toughning, etc [31]. These problems are overcome by the use of microwave susceptor films which absorb and convert the electrical component of microwave energy into infrared energy which is then transferred to the food being cooked [5]. The performance of susceptor depends on several factors like oven wattage, distance of food from susceptor, initial product temperature, food size, susceptor size etc [5]. The most commonly used susceptor is aluminium coated polyester films laminated into a rigid support like paper or paperboard which prevents shrinkage due to higher temperatures of cooking [5]. The aluminium absorbs the microwaves and becomes a secondary source for heating of food in localised areas providing browning and cryspiness of that area [5]. Researches are being carried out to prodce customized susceptors using other metals like nickel, iron, cobalt and stainless steel [5].

Microwave reflective materials

Microwave reflective materials are those that do not absorb the microwaves, rather reflect them and thus do not heat. Oven walls are made up of these reflective materials which helps the microwaves striking the walls of microwave to reflect to the food material [5]. These materials however, should not be used alone in microwave ovens as they may result into arcing under certain conditions [5]. However under proper conditions and circumstances, some metal containers like aluminium foils can be used but with caution [5].

2. Conclusion

Various types of packaging materials are being used for packaging and processing of thermally processed or preserved foods. Customized packagings are designed as per the suitability or requirement of the particular thermal processing for better results. The importance of giving special focus to the packaging materials is well-understood and because of this many developments are being done everyday in this field. Improvents in packaging materials for better retention of product flavor, colour, nutrients, less processing time, elongated storage life, ease of handling, low costs, are being done. However, the most important factor to cosider is still the safety of use of the package. The packages should not compromise with the time-temperature combinations required for ensuring the product safety and should not leave or produce toxic or harmful components in the food that may compromise the consumer safety. Various regulations have been established by the national and international organisations specifying the proper use of the packaging materials for foods.

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