International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume: 3 | Issue: 3 | Mar-Apr 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 - 6470

Aseptic Packaging – A Novel Technology to the Food Industry

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***How to cite this paper**:* Sanjana M. C. | Hemegowda R. | Sushma R. E. "Aseptic Packaging – A Novel Technology to the Food Industry" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-3, April 2019, pp.307-310, URL: http://www.ijtsrd.com/papers/ijtsrd22779.pdf

IJTSRD22779

ABSTRACT

Aseptic packaging is very well accepted in food and beverage applications worldwide as a safe and high-quality packaging option. Aseptic processing is the process by which a sterile (aseptic) product (typically food) is packaged in a sterile container in a way which sustains sterility. Aseptic processing sterilizes food products by destroying the harmful bacteria and pathogenic micro-organisms through a tightly controlled thermal process and combines the sterile product with the sterile packaging material in a sterile environment. Thus, the shelf-stable product requires no refrigeration. Basic operations in aseptic packaging are heating the product to sterilization temperatures (140-150°C for few seconds), maintaining the sterility of the products till they are cooled/packed and filling into sterile containers and sealing aseptically. Packaging materials play a very important role in packaging the products so 1st generation materials are paper board/plastic/foil/plastic laminates and 2nd generation materials are plastic containers. Aseptic Packaging offers the important advantages they are food safety, convenience, affordability, cost-effective in transport and storage with minimal environmental impact, no need for a cold chain. Innova Database analysis indicates that the dairy and soft drinks markets most readily utilize aseptic packaging. More recently aseptic packaging has been applied for wine, small particle foods like soups and salsas, waters like natural spring water, vitamins and energy water drinks and customized functional waters. New product applications in aseptic packaging are in traditional core segments like Juices, Iced teas, Dairy-based beverages, and Low acid foods.

Keywords: *Aseptic process, Food, Sterilization, Materials, and Packaging*

INTRODUCTION

The production of a commercially sterile product by continuous UHT (Ultra-high temperature) processing requires a means of packing which will ensure continued product sterility with the attainment of expected shelf-life. Such a requirement is fulfilled by aseptic packing. Aseptic processing and packaging denotes the filling commercially sterilized and cooled product into pre-sterilized containers under aseptic conditions and sealing in an atmosphere free of micro-organisms (Ansari and Datta, 2003).

Aseptic packaging is a packaging approach where the product is packed under aseptic conditions. The history of aseptic packaging abandons to the early 20th century. A patent was filed for a process, termed as aseptic conservation process in Denmark, prior to 1913 by J. Nielson-following Orla Jensen which was obtained in 1921. The first aseptic filling plant was commercialized in the market by Dole which used superheated steam at 210ºC for sterilization. The first aseptic filling plant for milk was presented in Switzerland in 1961 (FDA, 2018). The most significant development in this field is the development of a commercially viable packaging plant for milk, i.e. the Tetra Pak system, following the growth of the UHT process for milk.

According to David (2013), Aseptic packaging can be defined as the filling of a commercially sterile product into a sterile container under aseptic conditions and hermetically sealing the containers so that reinjection is prevented. This development in a product, which is shelf-stable at ambient conditions. The term “aseptic” is derived from the Greek word “septicos” which aids the absence of putrefactive micro-organisms.

Methodology

Aseptic processing comprises the sterilization of the products before filling. Sterilization of packaging materials and closures previously filling. Sterilization of aseptic establishments before operation (UHT unit, lines for products, sterile air and gases, filler and relevant machine zones). Maintaining sterility in this complete system during operation; sterilization of whole media entering the system, like air, gases, sterile water. Production of hermetic packages (Fellows, 2000).

Forms of Aseptic packaging are Tetra pack cartons - Tetra Pak group of Sweden had launched various types of cartons and 'Tetra Hedron' cartons were the first type introduced in the fifties, which required the growth of heavyweight paper board/aluminium/polyethylene and have proved to be quite successful for UHT milk packaging. The Tetra Pak Company had gradually replaced these Tetra Hedron cartons with Tetra Brick cartons as the former posed problems of collating and stacking and short shelf life (Smolin, 2017).

Characteristics of Aseptic packaging are low water-vapor transmission rate. Low gas transmission rates, especially to oxygen. This is valuable to preserve the color, flavor and nutritional constituents in the products. Good physical or mechanical strength, adequate to resist any physical damage during manufacture, handling, and distribution. Good sealing characteristics to forbid the entrance of external contaminants and ability to perform into automatic fabricating and filling equipment. Resistance to withstand the temperatures encountered during filling of the product as well as during storage and distribution. Chemically resistant to the product packed and ability to endure sterilization packing material with a gas, liquid radiation. Resistance to microbes, insects and other types of biological hazards. Compatibility with the milk packed. The constituents and additives etc. of the packaging material should be inert with low migration levels in accordance with the suitable codes of practice and standards of the country. Economical in cost in comparison to the packaged product and readily available in the market (Fellows, 2016).

Aseptic package contains structure and composition that not only to protect the product but also to maintain the quality of the product. Hence the structure as well as the composition of aseptic packaging are greater complex and alter depending on product application, package size, and package type. Components such as seal strength and integrity, package shape, stiffness, and durability, as well as hurdle properties determine the choice and/or combination of materials required. Generally, to achieve all required properties, aseptic packages includes more than one material in the structure that is put together by lamination or co-extrusion process. The packaging material must be agreeable with the product intended to be packed and must adhere with applicable material migration requirements. The physical integrity of the package is necessary to assure containment of the product and supply of sterility. The packaging material must be able to endure sterilization and be compatible with the methods of sterilization. The package must protect the product from oxygen, also package must retain the aroma of the product (Hargreaves, 2018).

Sterilization of Aseptic packaging materials and equipment: Sterilization agents are Heat, Chemicals, and Radiation. The heat was used as the sterilant for aseptic systems as a natural extension of thermal processing. Product supply lines and fillers are mainly sterilized by 'moist' heat in the form of hot water or saturated steam under pressure. To sterilize equipment 'Dry' heat, in the form of superheated steam or hot air is used. Hydrogen peroxide is using as a chemical sterilant. Other chemicals which have been used as sterilants, mainly for use in systems for acid food, include various acids, ethanol, ethylene oxide, and per acetic acid. Most aseptic packaging systems use hydrogen peroxide (at concentrations of 30 to 35%) as a sterilant for packaging materials than by hot air (60°C to 125°C) to expend residual hydrogen peroxide. Gamma-radiation has been used for decades to decontaminate packaging materials for use in aseptic systems for packing acid and acidified food. Aseptic packages are evaluated in bulk at commercial irradiators due to the penetrating powers of gamma-radiation. Other types of radiation are not widely used in aseptic systems. To decontaminate food contact surfaces Ultraviolet (UV-C) light has been used. The low penetration and problems associated with 'shadowing', limit the use of UV-C for aseptic systems packaging of low acid food (Handbook of food safety engineering, 2011).

Properties of aseptic packaging: a higher degree of safety, hygiene and nutrient retention in food. Preserving taste and freshness, which can be kept for months with no need for refrigeration or preservatives. Efficient (a filled package weight is 97% product and only 3% packaging material), using a small number of materials necessary to achieve a given function. A good example of resource efficiency is its light-weight (among the lightest packages available).

Applications of Aseptic packaging

Mainly, there are two specific fields: First field in the packaging of pre-sterilized and sterile products. It includes milk and dairy products, puddings, desserts, fruit and vegetable juices, soups, sauces, and products with particulates. Secondly, in the packaging of the non-sterile product to avoid infection by micro-organisms. Examples are fermented dairy products like yogurt.

Aseptic packaging of milk: Aseptic or long-life milk was originally introduced in Sweden called the "Tetra-pack" system. It consumes a laminate pre sterilizer and a filling environment heater. Aluminium foil is an integral part of the flexible laminate in order to provide a barrier against light and gas. In UHT processing, milk is preheated to 73– 850C then rapidly raised to 135°C for fraction of second and then suddenly cooled by flashing into a vacuum chamber. It must be packed under completely sterile conditions. No refrigeration is necessary for at least 3-6 months. If kept under refrigeration a shelf life of up to one year is possible. In the distribution system, the pouches are maintained in reusable multi-trip plastic crates. Tetra Pak aseptic cartons are formed of three basic materials that together result in a very efficient, safe and light-weight package. Each material gives a specific function. Aseptic containers may extend in size from a few fluid ounces to a nearly 8-million-gallon aseptic tank on an ocean-going ship. Worldwide export and import of new, economical and safe food products done by aseptic processing. Other common package types are drink boxes and pouches (Hersom, 2009).

Consumer packages: A great variety of packages may be aseptically filled now as Carton Boxes: Some of the existing aseptic carton boxes may now be filled with particulates, also aseptically. Bags and Pouches: Pillow pouches are mainly used for packaging of milk; three-sided sealed pouch, however, is advisable also for aseptic packaging of particulates up to particle sizes of 12μ and bag sizes from 1-5 liters. Cups and Trays: These are either used pre-made or formed, closed and sealed in thermoform/fill/seal machines. Both types of machines endure for filling particulates and also in packs advisable for microwave heating. Bottles and Jars: Glass bottles may be aseptically filled with food containing small particles, for instance for baby food. Jars may be filled with larger particles -12mm cube size or larger

-if one dimension is smaller (Nelson, 1993). In a recent development, returnable bottles are filled aseptically, which up to now be applied only for UHT – treated milk. Mainly, the same products can be filled into plastic bottles and jars as into glass containers. Closing is usually done by heat-sealing aluminium lids. So, much attention has to be paid to avoid contamination of heat-sealing rims. Plastic Cans: Two-piece plastic cans, 'gourmet cans', was recently developed in an aseptic machine for filling and closing. Cans and lids with easy opening feature exist of PP/EVOH/PP. They are sterilized with hydrogen peroxide, UV radiation and heat-sealed inductively (Smith, 2004).

Special need for plastics in aseptic packaging: Plastic material is so important to aseptic packaging; it is useful to discuss some special properties demanded of plastics by the aseptic process itself. They are chemical resistance and wettability, thermal stability, low levels of contaminating microorganisms and resistance to ionizing radiations (Stevenson, and Chandarana, 1999).

Bulk Aseptic Packaging: 'Aseptic Bag-In-Box' system caters to the packaging of 'High' as well as 'Low' acid products and products containing particles for filling range from 25 liters up to 1140 liters. Applications are in fruit juices, concentrates, purees, tomato products, milk and cream, coconut products and jam. Advantages of bulk aseptic packaging are safety, reliability, extended shelf-life and product quality. Safety due to the steam sterilization of spout, and sterilization effect can be controlled and recorded, no chemical sprays used to sterilize the chamber, the spout is tamperproof, safer sterilization and easier to monitor, no risk of adding chemicals to the product and no risk of laminate material relating with chemicals. Reliability, because of the filling machine is uncomplicated as there is no sterile chamber, the filling is controlled by weight this ensures accuracy as no adjustments for specific gravity need to be made and the customer will have one partner with worldwide service organizations and long experience in processing and packaging technology. Extended shelf-life due to the high oxygen barrier of the laminate, the laminate is less susceptible to flex cracking, secure spout with limited possibility of oxygen permeation and there is no headspace in the bag. A bulk aseptic bag is several layered structures consisting of an outer barrier laminate and an inner bag in contact with the product. Most of the bags are pre-sterilized using gamma irradiation and supplied flat. The level of gamma irradiation is specifically selected to facilitate packaging of high as well as low acid products (Pillai, and Shayanfa, 2014).

Advantages of Aseptic packaging technology: Food safety in cooking and packaging process ensures that the liquid is free from harmful bacteria and contaminants. No refrigeration required that saves energy both in transportation and in storage. Aseptic packaging requires limited energy to heat and sterilize the product than some other packaging methods. Nutrition benefits process places less heat stress on foods than canning, therefore, the product can contain more nutrients as well as taste, color, and texture.

Advantages in logistics: Lower transport weight: A one-liter beverage carton weighs only 28 grams versus a glass container which weighs up to 380 grams. Lower storage costs, warehousing efficiency, good stack-ability, improved pallet utilization configuration, empty packages are stored flat until ready to be used (unlike glass or cans). A standard semi-trailer truck can transport 1.5 million empty drink boxes versus only 150, 000 glass bottles. Space efficient in transport when filled. The brick shape allows more product able to be stacked in the truck (Smith, 2004).

Safety due to the steam sterilization of spout and sterilization effect can be controlled and recorded. No chemical sprays used to sterilize the chamber. The spout is tamperproof. Safer sterilization and easier to monitor. No risk of adding chemicals to the product. No risk of laminate material relating to chemicals. Reliability, because: The filling machine is uncomplicated as there is no sterile chamber (Smolin, 2017). The filling is controlled by weight. This gives accuracy as no adjustments for specific gravity need to be made.

Environmental impact: Renewable raw material - aseptic cartons are based on a renewable resource paperboard from wood. Lightweight, transportation efficiency, storage without cooling, energy efficient productions are resource efficiency. Aseptic cartons are the recyclable material which is easy to recycle and are being recycled where respective collection systems exist. Aseptic cartons have a good performance in fossil resource. Consumption and greenhouse gas effect which impacts global warming (Willhoft, 1993).

Conclusion

Aseptic packaging has very well occurred in food service applications worldwide as a safe and high-quality packaging option. Aseptic processing sterilizes food products by destroying the harmful bacteria and pathogenic micro-organisms through a tightly controlled thermal process and combines the sterile product with the sterile packaging material in a sterile environment; the final result is a shelf-stable product requiring no refrigeration. Packaging for aseptic was particularly demanding of the long shelf-life, high seal integrity, and consumer appeal. The use of plastics in the aseptic packaging mainly increases the non-refrigerated shelf life and need of many perishable products. Today, this is primarily being used in the innermost contact layers of the package, thereby protecting the quality of food. More recently aseptic packaging has been applied for wine, soup, baby food, and water products.

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