PM Formalisation of

Micro Food Processing Enterprises (PM-FME) Scheme

HANDBOOK OF

READY TO EAT EXTRUDED SNACKS

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Snack foods have always been a significant part of modern life; they represent a distinct and constantly widening and changing group of food items. Consumer appeal for ready-to-eat (RTE) products is forecast to grow rapidly over the next 5 years as consumers demand convenient snacks with exciting sensory and textural properties. Extrusion technology has been used extensively in the production of cereal RTE snacks due to its ease of operation and ability to produce a variety of textures and shapes which appeal to consumers.

Designing snack foods today can be a complex process to meet changing consumer's taste and expectation, for example, 'good for your health,' 'rich source of protein,' 'offering a unique flavour,' and the elusive search for something unique that also appeals to a wide variety of people. Most snack manufacturers use some form of existing technology as the basis for creating snack products, but incorporate variations that increase the resulting snack's health image appeal by lowering fats and calories or adding nutrients.

1.2 Snack food consumption pattern

The snack food market is constantly changing relative to product types, and although most snacks are not primarily consumed for their nutrients, many snacks are made with nutrition in mind. The snack food industry is experiencing extraordinary changes from the consumers' point of view. Consumers want snacks to not only taste good but also smell good, feel good, and look good. Snacks should give the consumer a homemade/fresh feel. Some of the snacks are developed with a special theme in mind like world soccer. These snack pellets are soccer ball-shaped, which on frying or treating in a microwave oven become soccer balls.

Snacking rises due to an increase in factors such as one person households, higher proportions of working spouses and more school-age children obtaining their own meals and refreshments, a highly mobile population, and availability of snack foods in vending machines and convenience markets.

Various products, which were once consumed mainly on impulse, are becoming accepted as side-dish items, for example, corn chips or potato chips served in place of mashed potatoes. The established position of snack foods in the diet is demonstrated by the continuous growth in sales. In the last 10 years, changes in lifestyle and eating patterns have led to a gradual increase in demand for snack foods. The pattern of snacking in different countries can be affected by several factors such as the lifestyle in each area, the economic climate, rival foods, and public receptiveness of current views on nutritional matters. Snacks can provide an increased dietary intake of essential amino acids and other nutrients for developing countries. Some of the most recent factors driving the newer snack food trends are as follows:

(1) Availability of Healthy Snacks
(2) Better Taste and Flavours,
(3) Better & Attractive Shapes, Packaging, and
(4) Better Varieties of Snacks.

1.3 Classification of snacks

1. First-generation snack foods: In this category, all the natural products used for snacking, nuts, potato chips, and popped popcorn, are included.

2. Second-generation snack foods: The majority of the snacks such as all the single-ingredient snacks, simple-shaped products like corn/tortilla chips and puffed corn curls, and directly expanded snacks are included in this category.

3. Third-generation snack foods (also called half-products or pellets): In this category, snacks and pellets formed using multi-ingredients, made by extrusion cooking, are included.

1.3.1 Ready-to-eat Foods

Ready-to-eat (RTE) foods are increasingly popular with the consumer predominantly due to their convenience of consumption and ease of preparation and storage and consumer appeal factors such as convenience, value, attractive appearance and texture. The Food Standards Agency (FSA, UK) defines ready-to-eat products as: any food for consumption without further heating or processing. This definition covers both open and pre-wrapped ready-to eat products and is intended to apply whether the ready-to-eat food may be consumed hot or cold. The expression 'further heating or processing' is not intended to include food preparation activities such as light washing, slicing, chopping, portioning, marinating or preservation carried out by the consumer by way of preference to an otherwise ready to eat food item.

Under this definition, a number of processed foods can be regarded as RTE products including biscuits, crisps, breads, pies, sandwiches and rolls, dairy products (milk, cheese, spreads), prepared salads and vegetables and fruit. The list can be extremely long and with new products entering the food market nearly every day, the list is getting longer and longer. One of the most important sectors of the RTE product market is the cereal RTE segment. This is traditionally dominated by extruded snack products, for instance, breakfast cereals, extruded cereal shapes and cereal biscuits/bars. The majority of these cereal RTE products were derived from whole-grain sources and were predominately flaked from steamed grains (the steam making the grains pliable to be reformed by the flaking process). Along the same line, snacking on extruded (expanded and pellet forms) is becoming very popular among the health-conscious consumers.

CHAPTER 2

PROCESSING OF RTE SNACKS

2.1 Extruded snacks

This category has the greatest potential for growth among the snack foods. The snacks can be produced using innovative methods that capture the consumer's imagination. Some of the examples are three-dimensional snacks and snacks with a variety of shapes such as animals, cartoons, and alphabets. Producing a successful snack is a fine balance between the consumer's needs, like tastes and interests, and the manufacturer's production abilities, economics, and quality control. Raw material cost plays an important role in the finished product's selling price. Therefore, it is an advantage to use the lowest-cost raw material to produce a successful snack.

2.2 Common ingredients used for extruded snacks

Presently, snack products are being made from a variety of ingredients. However, the selection of the ingredients was limited by the equipment availability. The introduction of the extrusion process, other processing equipment's, and better knowledge of extrusion technology have led to more diverse and complex formulations for snack foods. The most common sources of ingredients are corn, wheat, rice, potato, tapioca, and oats. This is not an inclusive list and one should not limit his or her snack food formulation based on these ingredients. There are several other sources of ingredients for snack food all over the world. A major ingredient in snack food formulation is starch. In its natural form, the starch is insoluble, tasteless, and unsuited for human use. To make it digestible and acceptable, it must be cooked.

2.2.1 Cereal sources

Almost any cereal can be extruded, but if expansion is a major objective, a number of functional cereals are limited to degermed corn/grits and rice. Cereals that have high amounts of lipids are more difficult to expand due to dough slippage within the extruder barrel. This type of cereal usually requires high moisture and high temperature before significant puffing can occur. In general, starches with 5–20% amylose content will significantly improve expansion and texture of the snack foods. The most common cereals used in snack food formulations are described later in the text.

2.2.2 Corn

Extruded snacks are a growing segment of the corn-based market. Corn (also called maize) is a primary ingredient for corn collets and many pellet products. For most corn-based extruded snacks, dry-milled cornmeal is used. Large quantities of cornmeal are used in puffed extruded snack production and some are used in corn chips. Cornmeal, corn grits, corn flour, and corn cones are all a different form of dry-milled dent corn and in general vary only in particle size distribution. Selection of the granulation depends upon the type of snack and type of extruder. For example, for fine texture and cell structure, or softer bite, a fine granulation of cornmeal should be used, whereas for crunchy texture with a slightly larger cell-structured snack, a more coarse granulation of corn meal is desired. Similarly, a twin screw extruder can handle fine and coarse granulation corn flour, while collect extruders require coarse granulation. Mostly, degermed corn is used in extruded snacks because it expands better than whole corn. Yellow and white corns are most commonly used in snack foods.

Corn starch granules are medium in size (5–20 mm) and have very good expansion characteristics. The protein content of corn ranges from 6% to 10%. Snack food formulations with corn have a definite flavour. Corn starch is usually cooked at a medium to higher temperature during extrusion. The function of the starch in snack foods is to achieve various textural attributes and characteristics. Changing the amylose/amylopectin ratio in the starch can change these attributes. Today, we can find corn starches with high amylose or high amylopectin in the market. High-amylose corn starches are used when crunchiness and strength is required in the snack. To increase the expansion of the snack, high-amylopectin corn starches (waxy starch) can be used. Waxy corn contains very little amylose, whereas the normal corn contains 25–35% amylose. Under high-shear and high-temperature cooking, a cross-linked waxy corn starch is recommended in snack foods, since it exhibits an improved property of resistance to amylopectin breakdown.

2.2.3 Wheat

In general, wheat can be classified into two types: hard and soft. Hard wheat is higher in protein, produces stronger flour, and is better for bread making. On the other hand, soft wheat is lower in protein and yields weaker flour, which is better for cake making. In the snack food industry, wheat flour is used in formulation for making baked and fried snacks, flavoured crackers, snack cakes, pretzels, bread, and the like. Semolina (coarse particle), usually produced from hard wheat milling, is also used in snack food formulation. The semolina product has an expansion ratio and bulk density about the same as cornmeal. All semolina snack foods will produce a very crispy texture. Wheat starch granules are fairly large (20–40 mm) as compared to other cereal grain starches. In wheat, amylose and amylopectin are found within a narrow range of 20–25% amylose. It gives good expansion during extrusion cooking. Wheat is relatively higher (8–15%) in protein than other cereals. Sometimes, it is difficult to expand due to the presence of gluten. In extruded snacks, wheat gluten provides nutritional value, crispness, and desired texture. In general, 1–2% wheat gluten is used in snack foods. Hard wheat is commonly used in bread rolls, pretzels, and fabricated or pellet-type snacks. Wheat varieties with a lower gluten level give a tenderer expanded product than semolina or hard varieties. Snack products made with wheat usually have mild flavour and white to off-white colour. It needs medium to low cooking temperature during extrusion cooking. Milling by products (bran) can be used with soy protein and some other ingredients to produce expanded snack foods of high nutritional and fibre value. The use of wheat in snack food formulation is limited because of cost.

2.2.4 Rice

Rice is one of the largest crops grown in the world. Four types of rice are produced in the United States: long, medium, short, and waxy grains. In the United States, rice ingredients are not commonly used in snack food formulation. In Japan, most of the snacks are made with rice or rice flour. One major reason is the cost of rice as compared to that of other snack food ingredients. Broken rice can be used as ingredient in expanded or puffed snack products, since rice has good expansion qualities. Rice starch granules are the smallest (2–8 mm) of all grain starches and can be digested very easily. Its functional properties are very different from corn or wheat starches. The primary difference is in amylose/amylopectin ratio in the starch. Flours from different rice varieties have major differences in physical and chemical properties, which can affect the snack cell structure and expansion.

For example, long-grain rice flour can increase the crispiness in snack foods, whereas waxy rice flour can reduce chip hardness and at the same time can provide a melt-in-the-mouth texture usually achieved with extra fat. Rice is commonly used as a carrier product for other flavours, since it is bland in flavour. In comparison with other products, rice requires the highest temperature during extrusion to cook a snack. Selection of the rice starch in the snack food formulation will depend on the amylose content of the common rice varieties. Long grains have 22–23%, medium grains 15–19%, and waxy grains <1% amylose. This difference in amylose/amylopectin ratio greatly affects the gelatinization temperature of rice flour. The protein content of rice ranges from 6% to 8%.

Rice flour could be used for texture improvement in multigrain snack foods. Rice flour can be mixed with masa flour, potato flakes, or bean flakes. Chips made with 100% rice flour absorb 20–30% less oil during frying. In a formulation where rice and potato blend is used, the potato flavour and texture remains distinctive even though it is mixed with the less costly rice blend. A mixture of bean flake and rice flour produces a distinct visual appearance of the beans while creating a well blended bean flavour with no bitter aftertaste.

2.2.5 Oats

In general, oats are marketed as rolled oats or as an ingredient for breakfast cereal. Oats have not been used in grain-based snacks as wheat and corn. Recent discoveries that oat bran can reduce serum cholesterol level in humans have boosted the market for oats in the snack food industry. The major problem with oats is the high oil content (7–9%) and lipase enzyme. Before using oats in the snack food formulation, it is desirable to inactivate the lipase. Otherwise, lipase will catalyse the hydrolysis of oil, which would lead to the reduction of bitter tasting free fatty acid. Oat starch granules are comparatively small (2–12 mm) in size as compared to other starches. Amylose content of oats varies from 16% to 27%.

Oat starch has a very strong flavour and it gives a light brown colour to the product. It requires a relatively low gelatinization temperature, but a higher amount of energy input for cooking because of higher amounts of oil content. Oats contain high levels of fibre. Snacks extruded with oat starch expand poorly. For this reason, it has only found its way into products at low levels. By using longer barrel extruders with preconditioner, a higher level of oats can be used in snack foods. Among the snacks that have traditionally included oats in their formulation are cookies and granola. With new technologies and more interest in oats due to health claims, oat-based snack products may be popular in the future.

2.2.6 Barley

Barley is used in small quantities in some snack food formulations. It has a mild flavour, and nutritionally, it is almost the same as wheat, except it contains considerably more fibre. Barley starch granules are medium to large in size as compared to other cereals. A reasonable amount of expansion can be obtained during extrusion of snack foods using barley starch. It gives a light brown to gold colour to the product. Snack food formulation containing barley starch needs a low cooking temperature during extrusion. Barley fibre can be used in healthy snack foods as a fibre supplement. Sometimes, manufacturers use barley in multigrain snack foods in order to add one extra cereal on the label.

2.2.7 Other cereal sources

Cereals such as rye, sorghum, millet, amaranth, and triticale have been used in snack foods. Presently, these cereals are not major ingredients in the snack food formulation.

2.2.8 Tuber sources

Roots and tubers belong to the class of foods that basically provide energy in the human diet in the form of carbohydrates. According to a recent estimate by the Food and Agriculture
Organization (FAO), virtually every country in the world grows some species of root crop. Potato and tapioca (also called cassava) are two main tuber crops used for extruded snack foods.

2.2.9 Potato

Different forms of potatoes (granules, flakes, flours, and starches) are used in snack food formulations. Potato starch is often used in snacks to provide extra expansion. Potato starch has a wide range of sizes with some granules (60–100 mm) larger than the other cereals. This starch contains 20–25% amylose and has very low oil contents. Potato starch develops high viscosity during extrusion cooking. It has an excellent swelling and binding power. In snack food, it has a definite flavour and it gives gold to light brown colour to the product. It requires low cooking temperature since its granules break down easily. Potato flour is the major ingredient for two common snack products, that is, direct expanded snack (product looks like French fries) and fabricated chips.

2.2.10 Tapioca

Tapioca (cassava) is a basic source of low calories or a supplement to cereal. In general, tapioca starch is used in third generation snack food formulation. Tapioca starch grains vary in shape and size, from 5 to 35 mm. The amylose content is 17%.

Good quality starch should have a pH of 4.7–5.3 and a moisture content of 10–13.5% and should be uniformly white in colour. Tapioca starch develops a very high viscosity and it is an excellent binder. It has a bland flavour and requires moderate cooking temperature during extrusion cooking.

2.3 Other extruded snacks

2.3.1 Expanded Snacks

The majority of extruded snacks are in this category. This group is also referred to as ‘collet’ or ‘second-generation snack foods. In general, expanded snacks are made on high-shear extruders. These are high-fibre, high-protein, and low-calorie snacks. Some examples are corn curls, onion rings, three-dimensional snacks, and potato sticks. These types of snacks can be seasoned with a variety of flavours, oils, salt, sugars, etc. The quality of an expansion-cooked product depends on the conditions of operation of the extruder and the main raw material used in the formulation. Several other factors can influence the degree of puffing of snacks during extrusion, that is, the amount of moisture in the feed material, dough residence time in the extruder barrel, and cereal particle size.

2.3.2 Fried collets

These are the most familiar extruded snacks in the market. A special die arrangement gives the product a twisted and puffed shape. These collets are made on collet extruders. The product is then fried in vegetable oil and coated with cheese and some other flavour.

During frying, the moisture level reduces from 8% to 1–2% in this product. The most common material used for fried collet is cornmeal. Some other cereal grains can also be used for this type of product.

2.3.3 Baked collets

Baked collets are another example of the expanded extruded snacks. These include products such as baked corn curls, onion rings, and potato sticks. Baked collets can be made with different cereal grains and tuber flours. Protein, fibres, cellulose, and bran can be blended with cereal grain up to 20% to make healthy snacks. Potato sticks are usually made by mixing potato flour with corn or rice flour.

2.3.4 Third-generation snack foods

Third-generation snack foods, also referred to as 'half-products' or pellets, provide an alternative to fully prepared puffed snack foods. Third-generation snack foods, or half-products, are extrusion-cooked and formed at low pressure to prevent expansion and then dried to a final moisture content of 10% to form a glassy pellet. In developing third-generation snack foods, 'half' of the process is completed to prepare 'pellets' that are shelf-stable for periods of up to a year without refrigeration, provided they are properly packed to retain their moisture. These products are economical to run and have built-in marketability due to their high-bulk density.

Third generation snack foods can be prepared in homes or restaurants. Unlike typical snack foods, half-products do not yet contain oil that can oxidize to give off-flavour to the products. These pellets can be shipped from a central manufacturing distribution point, held until needed for the market, and then puffed, flavoured, and packed fresh and locally. New variations of the third-generation snack foods expand using infrared heating, hot air, or microwaving. The use of hot air systems reduces the oil uptake that occurs in frying and allows a controlled addition of oil to be made as required for flavouring.

With consumer concerns about fats and oils, a half product snack that expands using hot air offers snack food manufacturers an oil-free snack with perceived health benefits. The elimination of frying oils reduces calories and allows a marketing opening for snacks with a 'lite' image. With the multidimensional snack system, a wide range of raw ingredients can be used to blend together to make an excellent formulation for many types of third-generation snack foods. The extruder feed must contain a high level of starch to maximize expansion of the collet during exposure to hot oil or air. Levels of 60% or less total starch in the formula give only a slight expansion in the puffing step and yield a final product with a crunchy, hard texture. Wheat, corn, and tubers are widely grown crops in developing and industrialized countries, and they are cheaper and more easily available in the market than other cereal crops.

2.3.5 Coextruded Snacks

This is a relatively new technology introduced in 1984 for the snack food industry. In this process, two different materials are extruded from one die. The two materials can come from two extruders or from one extruder and one pump. This process can produce a snack with two different flavours or two textures or two colours. The most common snack produced by coextrusion is a cereal-based outer tube with a cheese filling inside. There are three basic types of coextruded snacks in the market: cereal based tubes with cereal-based fillings, cereal-based tubes with fat-based fillings, and cereal-based tubes with water-based filling. The shelf lives of these snacks are limited, because of th migration of moisture and/or oil from the filling to the outer shell. In conclusion, snacks can be processed by a variety of different methods and techniques. Several new raw materials containing nutraceutical and functional properties are being introduced in the market every day for snack food products. Snacks can be made with a combination of different raw materials containing different properties. The role of snacks in a healthy lifestyle is only now being developed. The recognition of snacks as healthy foods will increase as industry changes the products from those having merely good tastes to nutritious ones.

Popularity of extruded snacks food among consumer is due to

- Versatility
- Cost
- Productivity
- Product quality
- Environmentally friendly

2.4 Extrusion processing

India has a diversified culture in which food habits differ from one region to other region. In some region, people prefer “Roti” (flat bread) as their daily diet, whereas in other regions people prefer boiled rice as their daily diet. Developing a food product for such a diversified country is really a big deal. The need of Indian people to fulfil their daily calories can be achieved by developing a highly nutritious product. Diabetes obesity and other fatal diseases must be taken into account before developing a product, as these health problems are very common in people across the world. Health problems like chronic heart diseases (CHD), high blood pressure and osteoarthritis are arises due to eating habits and environmental factors. It is also due to consumption of significant amounts of high fat foods or fried foods.

A snack food developed using proper ingredients may help to overcome these health related problem. Due to versatile nature of extrusion process, it becomes easy to incorporate functional ingredients to the food products. For this reason, an extruded snack food with additional functional compounds like leaf powders (radish and fenugreek leaves) would not only enhance the nutritional value but also lower the adverse effects of such fatty foods. The principle advantages of extrusion technology as compared to conventional techniques includes

- Adaptability,
- Energy Efficiency,
- Product Characteristics,
- Low Cost,
- New Foods,
- High Productivity And
- Automated Control.

An extrusion is a technique of giving desired shape to the mixed raw materials. Extrusion processing is a synergistic effect of a series of unit operations, in which the raw material is inserted in the feeding chamber, which comes out as the final product through the die opening. Extrusion is a process whereas; extruder is equipment which shapes the material to desired form under pressure and temperature. In some cases, further dressings of the product like sprinkling of vegetable oils with some spices may be done to increase the appearance, flavour and taste of the product.

The following terminologies are required to understand food extruder and extrusion processing-

- Feedstock- the mixture to be processed in an extruder.
- Barrel- A pipe like retainer in which screws of extruder turns.
- Screw- which rotates in a tightly fitting cylindrical barrel. Raw ingredients are pre-ground and blended (called pre-conditioning) before being placed in the feeding system of the extrusion screw.
- Flight- the helical upper conveying surface of the screw which pushes the product forward. Working mechanism of the flights is based on the screw pushes the food products forward and mixes the constituents into viscous dough like mass. The characteristic extruded structure to the material comes out due to the cross-linking and/or restructuring due to alignment of long molecules in food constituents and all this happens due to the high shear production in the material by the flights of the screw(s) during the conveying of raw materials.
- Shear- A working, mixing action that not only homogenizes but also heats the conveyed product. The food product is undergone high shear rates (because flights on screw are full) as it is conveyed forward by the action of the screw. The area under high shear rate allows aligning food molecular constituents giving rise to cross-linking, resulting in the extruded foods characteristic texture.
- Root- the solid or shaft part of the screw, around which the flight is wound.
- Vent- small opening in front of die plate in the extruder barrel which allows pressure and steam removal from the product.
- Die- As food mixture material starts moving through the extruder, the pressure within the barrel increases due to a restriction at the barrel discharge. This termed as die (orifices or shaped openings), where the restriction is caused. Discharge pressures typically varied between 30-60 atm.

2.4.1 Extruder classification

Different extrusion equipment's are required for processing high intermediate and low moisture feed mixtures. Low moisture extrusion can be executed with single screw or twin screw extruders, but high moisture extrusion can efficiently be performed with a twin screwed extruder. As low moisture extrusion is often used to make ready to eat breakfast cereals and snack foods, so single and twin screwed extruders are being equally used. Process parameters affect the extrudates of both twin screw and single screw extruders. Variables that can be modified using extruder include screw speed, throughput rate, temperature, feed composition and moisture content.

As indicated by name, extruder consists of two screws. It is 1.5-2.5 times higher in cost as compared to single screw extruder. But it is having better filling, conveying, mixing, kneading, plasticization facility, and uniformity in the finished product also better control of product quality, ability to process at lower moisture level and greater operating range. Twin screw extruders are mostly preferred in industries. Twin screw extruders divided into different zones like melting zone, a mixing zone, a degassing zone and a discharge zone. Again depending on the rotation direction of both the screws, the twin screw extruder may be again categorized as:

- Co-rotating twin screw extruder and
- Counter-rotating twin screw extruder.

In both cases the screws lies side by side to each other. The only difference in mechanism is that, in case of co-rotating twin screw extruder, the screws rotate in the same direction (as shown in the figure) and in case of counter-rotation twin screw extruder, the screws rotate in the opposite direction. The relative direction of rotation of the screws in twin screw extruder may be counter or co-rotating. Extruder with more than one screw is called the multi-screw extruder. Single screw extruder (with one screw) comprises three sections: feed, transition and metering (mixing zone, conveying zone and cooking zone).

The extrusion screw sequentially conveys and heat food ingredients and works them into a continuous plasticized mass while rotating in a tightly fitting barrel. The screw can be designed either as a single piece or as a splined shaft that accepts screw sections of varying configurations to increase versatility and reduce the cost of replacing worn sections. When the screw rotates it creates the pumping action. The screw rotating in a tight barrel, creates high shear on the food material, which with the heating effect develops the plasticized mass.

2.4.2 Different Parts of the Extruder

Extruder is composed of following principal components. A brief description of components is given below:

2.4.2.1 Feeding mechanism

This section of extruder is usually composed of a conical shaped part (hopper) to receive the material to be extruded. To permit a better flow and reduce bridging or to avoid choking of the material, the feeder is equipped with an agitator or a large exit for constant agitation. To regulate the feed rate, one controller presents just behind the hopper. This helps in maintaining constant uninterrupted feeding, which is essential for the proper functioning of the extruder and also to maintain the homogeneity in the quality of the extrudate.

2.4.2.2 Screw

It is the vital part of the extruder, as it helps in regulating the degree of cooking and gelatinization, and also the quality of final product. Screw not only conveys the raw material from the feed section to the die, but also provides necessary pressure and shear to the material to form the structure of the extruded product. The quality of the final product is largely dependent on the screw speed.

2.4.2.3 Barrel or screw sleeves

Barrel is the main part of an extruder. The whole process of extrusion is performed in this section. Barrels hold the screw(s), the heating elements, heat sensors and die. Extruder screw is encased in the barrel and barrel must be sufficient strong to bear the high pressure developed during extrusion.

When the screw(s) rotate, a moderately high pressure generates in the chamber that is why the barrel material should be so selected and should be so thick that, the barrel can bear the pressure during extrusion cooking. Inner surface of the barrel may be smooth or contain grooves. Sleeves have usually straight or spiral grooves. Spiral grooves are more likely to impart high forward flow, while straight one hinder it. The later thus results in lower flow rate, but comparative more mechanical shear.

2.4.2.4 Heating arrangement

Heat is the fuel for the extruder. Heat is supplied through the extruder barrel to the feed during extrusion. Direct heating (by injecting steam) or indirect heating (with electric heaters, mounted on the barrels) is used. Depending upon the material used for extrusion, heat (or temperature) varies. The heat generally produced in an extruder is by the means of electric coils.

A series of electric heating coils are arranged in the barrel, with which heating sensors are attached to monitor the temperature digitally. The barrel is also equipped with two water inlet and two outlets to maintain the temperature as well as to avoid damage due to high temperature. Heating may be also done by the injection of steams into the barrel, but that would not be efficient as compared to coils.

2.4.2.5 Die

The end of the screw sleeve is normally equipped with a die. Design of die directly influences the shape and texture of the finished product. It moulds the product into the desired shape and works as a flow restrictor to increase the pressure in the cooking zone of extruder. It may be short, long, tapered or straight.

2.4.2.6 Knife or cutting mechanism

Ahead of the die, variable speed rotating knife is utilized for the formation of equal length extrudates. The product length is determined by the speed of cutting knife.

Faster the speed, shorter will be the product. Electric motor also termed as drive, rotates the shaft and the shaft further rotates the screws. The speed of the motor is regulated by a knob. Rotation per minute or RPM is one of the most important variables in every extrusion process which is regulated by that motor.

2.4.2.7 Expansion mechanism

Expansion is the consequence of the pressure difference developed between the inside pressure of the extruder and outside atmospheric pressure. Heat and pressure are developed while passing the food product through a barrel by means of restrictions in screw. There is a sudden decrease in pressure when the product got discharged into the outer atmosphere (out from the die), results in expansion of the product. Starch cells are ruptured by excess vaporization of moisture. The amount of expansion depends on several factors, such as starch content of the product, inlet-outlet temperature, pressure, and the amount of feed moisture.

2.4.2.8 Bubble growth and bubble collapse

Extrudate expansion is based on the biaxial extension of individual bubbles. Bubble growth relies on the pressure difference between both sides of the barrel. It is generally accepted that surface tension has a minor or negligible effect on expansion of polymer, with little effect on initial expansion. The rheological properties of the polymeric material have leading role in expansion, as they determine the resistance of the bubble wall to create the pressure difference across interior and exterior of the bubble. Bubble growth in a viscous fluid and interrelated specific volume of the extrudate with the ratio between vapour pressure and melt viscosity. The correlation was poor at higher moisture contents, is due to shrinkage that occurred in the high moisture content extrudates. Cessation of bubble growth has a direct effect on the final texture of the expanded product. When the melt leaves the die orifice and water vapours flashes out, with the drop of temperature due to evaporative cooling, the extrudate which reaches a glassy state after crossing the rubbery region (retro gradation), and expansion stops.

When the bubble wall cannot withstand the pressure inside the bubble, it collapses, typically above 20% moisture content. This phenomenon of bubble collapse is decided by extrusion temperature and material rheological properties. The collapse occurs particularly at low extrusion temperatures. In terms of rheological properties, low melt viscosities facilitates the bubble collapse. As, in the high pressure zone viscous melt obtained from the free flowing feedstock has visco-elastic properties.

Extruded foods and feeds are made from a diverse range of raw materials. These ingredients are similar in their general nature to the ingredients used in all other types of foods and feeds. They contain materials with different functional roles which play important role in the stabilization and formation of the extruded products and also provides preferable colour, flavour and also enhance nutritional qualities in different products. The transformation of raw materials during processing is one of the most important factors that distinguish one food process and food type from one another. For a particular product type, a selection of ingredient is processed through a set processing regime. If conditions are in the ideal processing range, a stable extrudate will form with the normal product. Extrusion cooking is a specialized form of processing, which is unique in food and feed processing because of the conditions that are used to transform the raw materials. A first feature that distinguishes extrusion cooking with conventional baking or dough processing is a relatively low moisture addition, generally 10–30% on a wet weight basis. Despite of this low moisture, the mass of raw materials (free flowing or low moisture powder/flour) is transformed into a fluid which is further subjected to a number of operations to mix and transform the native ingredients into new functional forms. Under these unusual process conditions, the physical features of raw materials such as the particle size, hardness and frictional characteristics of powders, lubricity and plasticizing power of fluids become more important than other food and feed processes.

A second feature that distinguishes extrusion cooking from other food processes is the use of very high temperatures, usually in the range 100–180ºC. The use of high temperatures reduces the processing time and allows a full transformation of raw material to its functional form in short duration, generally 30–120s. Almost all extrusion cooking processes are operated continuously with raw materials that fed into the processing units. All food and feed products have basic structures that are formed by certain elements in the raw materials such as the biopolymers of starch and proteins in baked products or fat and sugar in confectionery. The structural elements form the three dimensional cages or nest of girders in which the other materials are held to form the product texture. Extruded products are formed from the natural biopolymers of raw materials such as cereal or tuber flours that are rich in starch or oilseed, legumes and other protein-rich sources. The most commonly used materials are wheat and maize flours, but many other materials are also used such as rice flour, rye, potato, oats, barley, sorghum, tapioca, cassava, buckwheat, pea flour and other related materials.

If the extruded products are manufactured as texturized vegetable protein (TVP), the main ingredients will be selected from protein-rich materials such as pressed oilseed cake from soya, sunflower, rape, field bean, fava beans or separated proteins from cereals such as wheat (gluten). The native forms of the biopolymers were not designed for extrusion cooking and must be changed by processing to obtain a more useful polymer. All the natural biopolymers used in the ingredients listed above can be transformed into a fluid melt in the desired temperature and moisture range in an extruder. The skill in controlling the processing is to transform the polymers in a short period of time using the thermo-mechanical processing provided by the screw elements under the control of the die pressure. In a normal recipe, all the ingredients will interact with one another to affect the transformations taking place. Therefore, it is essential to understand the role of each individual material in the recipe and also to study the effect of any variation in an individual ingredient that affects the overall processing performance of the extruder.

2.5 Factors affecting the characteristics of extrudate products

2.5.1 Starch

It is the main component that provides the underlying structure of the finished product. Starch acts as the dominant polymer in most cereal systems, which plays a major role in expansion. The lower limit of starch content for good expansion is 60 to

70%. Starch is made of amylose and amylopectin, which creates differences in expansion. Higher amylopectin content help to develop light, elastic and homogeneous expanded textures, while higher amylose content results in less expanded and hard extrudates. According to some studies, 50% amylose leads to maximum expansion of starch. Amylopectin rich starches expand more than amylose based starches as the linear amylose chains align themselves in the shear field areas and consequently are difficult to pull apart during expansion. Amylopectin starches, at same moisture content are not as hard as amylose favouring their expansion.

Starch granules are gelatinized and dispersed during extrusion, resulting in the formation of a continuous phase of the melt inside the extruder. Average molecular weight is decreased, which allows for optimum formation and stability of air cells at the die exit. Both amylose and amylopectin are needed to give the best expansion characteristics.

2.5.2 Moisture

Water is the basic ingredient and main plasticizer in extrusion. It is needed for starch gelatinization and dispersion of ingredients. It aids in the formation of a viscous fluid from a free flowing form that is conveyed and cooked. Lowering down the moisture content of feed resulted in higher viscosity. Further, less moisture content in the product results in reducing the degree of expansion and hence, higher bulk density and smaller volume is achieved.

2.5.3 Fibre

Fibrous materials such as bran are part of the dispersed phase of extrudates, embedded in the starchy continuous phase. Fibre is chemically unaltered by the process, and it affects expansion of the product. The effect of fibres on extrudate expansion seems to be concentration dependent. Radial and axial expansion of rice flour extrudates increased with the addition 10% rice bran but decreased at higher levels (20% and 30%). It is reported that increasing the oat or wheat bran content in cornmeal up to 20% and 30% respectively, increased the bulk density and longitudinal expansion, but decreased the radial expansion. It is likely that at small concentration, the long and stiff fibre molecules align in the direction of flow in the extruder, reinforcing the expansion of feed material and uplifting its mechanical resistance in longitudinal direction.

The structural anisotropy becomes detrimental to the biaxial extensional properties of the extrudates, thereby lowering their radial expansion. Above a critical concentration, the fibre molecules interrupt the continuous structure of the melt, impeding its elastic deformation at the time of expansion. Fibre binds with the moisture present in the matrix, thus reducing its availability for expansion. Generally, soluble dietary fibres (SDF) and insoluble dietary fibres (IDF) are required by the body in the ratio 1:3.

2.5.4 Protein

Protein is one of the important contributing factors which influence the quality characteristics of extruded products as they related to structural integrity of protein matrix. Many types of proteins and protein enrichments may be added to extruded snacks such as meat, dairy products and legume proteins. During extrusion, protein structures get disrupted under pressure, high shear and temperature. Protein solubility decreases with cross-linking reactions and covalent bonds formed at high temperatures.The type of protein and additives added to the mix has an important impact on texture of the final product. During extrusion, polysaccharides form a separate phase which enhances protein aggregation in the direction of extrusion and reduce it in the direction perpendicular to extrusion.

Protein–protein interactions may be enhanced by decreasing the temperature and secondly by macromolecular alignment. The crystalline aggregation tends to formation of parallel fibres of varying thickness and length. The interaction energy is possible for cross-linking of protein and other molecules due to the diversity of the amino acids. Therefore, hydrophobic, cation– mediated electrostatic interactions and covalent bonds also contribute to the stabilization of the network formed after extrusion.

Researches claimed that new peptide bonds were responsible for extrudate structure and disulphide bonds had an insignificant impact on it.

The structurally extruded soy meal appears like a coextensive fibrous strand embedded in porous expanded structure. Examination of such extrudate by differential staining light microscopy reveals carbohydrate inclusions and steam generated voids enclosed within a protein rich matrix. Protein level and second order protein effect accounts for 77% of the variation in product shear values.

2.5.5 Effect of Extrusion on Water sorption isotherm of extruded product

Isotherms (or curves) give information about the sorption mechanism and the interaction of food biopolymers with water. The moisture sorption isotherms are significantly important in predicting shelf stability, in estimating moisture changes which may occur during storage and employing improper packaging material. The primary reason for rejection of these products by consumers is mainly the loss of crispness, which is determined by the amount of water absorbed during storage. One of the hypotheses concerning the loss of crispness assumes that water absorbed by the product dissolves intermolecular substances present in cell walls.

The explanation of mechanisms of protein interaction with starch during extrusion cooking. Extrusion cooking resulted in the development of a new structured product. The extent of structural changes may be calculated using water vapour sorption. The sorption properties of starch–protein extrudates developed at varied process parameters, using water vapour adsorption/desorption. The results showed that the sorption isotherms of the raw materials and the extrudates had same shape. The raw material always displayed higher absorption of water vapour as compared to the extrudates. Irrespective to protein material, extrusion resulted in a lowering of water vapour monolayer capacity. Milder temperature conditions increases the water vapour monolayer value. It was also shown that the specific surface area of the extrudates increased markedly with increase in their water absorption capacity.

2.6 Flow chart for extrusion of snack products

Raw materials (Wheat flour, corn flour, Rice flour)

↓

Sieving and Blending

↓

Premixing (Addition of water and oil and conditioned at 80°C for 15min)

↓

Twin screw extrusion (Feeder - 16rpm, 350rpm - screw conveyor for 30-120sec)

Temperature (Zone 1 -30°C, Zone 2 – 60°C, Zone 90°C, Zone 4 - 120°C)

↓

Rotary drying (80°C @ 50rpm) and cooling

↓

Dumbling mixer

Oil spray and flavouring (coating of spice powders)

↓

Packaging & Storage

2.6.1 Advantages of extrusion

2.6.1.1 Adaptability

The extrusion process is adaptable being able to accommodate the demand by consumers for new product.

2.6.1.2 Product characteristics

A variety of shape, texture, colour and appearances can be produced.

2.6.1.3 Energy efficient

Extruders operate at relatively low moisture while cooking food products, so less re-drying is required.

2.6.1.4 Low cost

- Low processing costs than other cooking and forming process.
- 19% raw material cost, 14% labour cost and 44% capital investment is required for start-up.

2.6.1.5 Less space

Extrusion processing needs less space per unit of operation than other cooking system.

The consumer demand for RTE snacks is showing consistent growth due to the convenient nature of snack products and also the appeal of RTEs for texture and sensory properties. Extrusion processing offers the food industry a method to produce consumer acceptable RTEs from relatively inexpensive cereal-based ingredients.

There exists a great potential for the global food industry to manipulate the nutritional status of these products so as to offer the consumer RTEs with a range of nutritional profiles from highly digestible starch and protein products for people indulging in sport activities for instance, to relatively low GI and high bioactive containing RTEs for those consumers interested in maintaining a balanced nutrition. During the next 10 years, we will undoubtedly see a preponderance of research investigating the effects of extrusion technology on the chemical and nutritional profile of RTE, which will help both the consumer and the food industry to benefit from current research investigating the food structure and nutrition interface.

IIFPT TWIN SCREW EXTRUDER

CHAPTER 3

PACKAGING OF READY TO EAT EXTRUDED SNACKS

Convenience food (RTE) is a concept that is prevalent in the developed world since long, while its inception into the Indian market has been recent. With the changing socio-economic pattern of life and the increasing number of working couples, the concept is fast becoming popular in Indian market. This type of food is becoming popular because it saves time and labour. This food has extended shelf-life and is available off the market shelves.

3.1 Types of extruded snack foods

The traditional items made from flours and spices and extruded in the form of sticks, strips or spirals such as sev, boondi, papdi, gathia, chakli etc. These items traditionally prepared in households are now marketed in pre-packed forms with different flavours and seasonings.

The non-traditional pre-formed partly cooked pellets derived from potato, starch from cereals and fried at high temperatures for a short time to give expanded light textured products. This group also includes cereal / potato powder mixes, which are extrusion cooked and enrobed with oil and flavor.

Many of these products are highly flavoured with spices, herbs or cheese. Typical examples are cheese balls, “cheetos”, “kurkure” etc. A large number of products are available in this category and display varying sizes, shapes and textures.

3.2 Packaging Requirements of Ready-to-Eat snack extruded (RTE) Foods

A “ready-to-eat” food product may be defined as any food product which does not require any

elaborate processing procedures on the part of consumer before it is good enough for consumption. It is ready-to-eat as soon as the pack is opened in a form, which is tasty and appetizing. Basic requirements for extruded snacks packaging include:

- Grease proof
- Rancidity
- Loss of crispiness
- Machinability
- Physical strength
- Printability
- Seal integrity

Some important packaging considerations, which influence the selection criteria for choosing packaging materials, are highlighted below

3.2.1 Greaseproof

The presence of fat indicates that the main requirement of snack food packaging is that it should be greaseproof. This requirement is of significance not only in reducing the rancidity but also to prevent unsightly staining of the package, smudging of the printing and to avoid the actual seepage of the oil and the greasy package feel.

3.2.2 Rancidity

Another requirement due to the high fat content is the prevention of the product coming in contact with the oxygen in the air. A packaging material with low oxygen permeability is desirable to be used, to prevent oxidation and rancidity of fat.

3.2.3 Loss of Crispness

One of the major properties of snacks is the crispness, which is achieved during the manufacture of the product by one of the drying methods such as roasting, baking or frying to reduce the level of moisture content. Retention of desirable texture (crispness) is directly related to the moisture level in the product. The moisture content of snack is very low, and any increase due to the hygroscopic nature of the product may lead to loss of crispness of the product. Moreover, added moisture also accelerates other biochemical changes such as oxidative rancidity. Low water vapour permeability of the package is, therefore, another very critical requirement. For predicting product shelf-life and package performance in respect of water vapour transfer, the data required are:

- The moisture isotherm data
- The WVTR of the film/laminate
- The storage conditions

Product	IMC (%)	CMC (%)	ERH (%) at IMC	ERH(%) at CMC
Potato Sev	1.40	3.30	16.00	43.00
Bhavnagri	1.00	3.20	13.00	42.00
Cheese balls	5.70	7.70	27.50	52.50

From the above results it is evident that these snack food are extremely moisture sensitive, and can easily absorb moisture even at low Relative Humidity conditions, and at CMC levels, loss of crispness occurs, rendering the product unacceptable to the consumers.

The Water Vapour Transmission Rates (WVTR) and Oxygen Transmission Rate (OTR) of some of the flexible packaging materials, which were assessed for snack food packaging is given below:

Packaging material	WVTR g / m² / 24hrs at 38°C, 90% RH	OTR cc / m² / 24 hrs at 24°C, 1 ATM.
LLDPE – Tie – Nylon – Tie – LLDPE (130µ)	0.24	0.55
12µ PET/12µ Al foil/ 80µ LD – HD	0.60	1.65
10µ PET/9µ Al foil/ 80µ LD – HD	0.74	1.90
12µ PET/12µ met. PET/ 80µ LLDPE	5.14	–
12µ PET/155µ LD – HD	2.20	105
12µ met. PET/135µ LD – HD	5.76	116
12µ met. PET/155µ LD – HD	3.60	110
12µ PET/135µ LD – LLD – HD	6.50	>999

3.2.4 Machinability

Some of the snacks have recently moved away from manual filling into preformed bags and are packed on automatic form-fill-seal machines which may run on fairly high speeds. Packaging materials must, therefore, be capable of running continuously and efficiently on these machines.

3.2.5 Physical Strength

Due to the high fat content of the snack food products and the associated problem of rancidity, in some of the packages, where longer shelf-life is the requirement, oxygen inside the package may be replaced by an inert gas like nitrogen. The packaging material must be physically strong to withstand the processes of vacuumising/gas flushing. The question of stiffness of the material is also debatable. It is desirable that the package should be able to stand up on the shelf, however, high stiffness leads to problems of machinability.

3.2.6 Printability

The packaging material should provide a good printing surface. Attractive printing is the order of the day as a number of brands of similar snack food have to compete in the market.

3.2.7 Seal Integrity

To ensure protection against environmental conditions and to provide a long shelf-life, the seal integrity of the pack must be good enough to prevent leakage and/or prevent entry of the air or moisture through the seal areas.

The above requirements for snack food packaging are met by plastics to a large extent in various forms such as flexible pouches of films and laminates, plastic containers and trays and as a component in the composite packs.

3.3 Product Characteristics considerations for selection of packages

- The type of food and its composition, moisture, fat, protein, flavour etc.
- Form and shape of the product – smooth, regular, irregular, with sharp edges etc.
- Nature of the product – crisp, brittle, sticky etc.

3.3.1 Factors responsible for the spoilage of the snack products:

- Biological spoilage due to micro-organisms
- Abiotic spoilage due to chemical reactions like oxidation, hydrolysis and enzymatic reactions.
- The environmental factors like light, humidity and temperature.
- The food processing parameters eg. processing temperature and duration.
- The shelf-life desired for a given ready-to-eat food, influences the type of packaging and processing parameters to be used.

3.4 Packaging Materials for RTE Snack Food

3.4.1 Flexible Plastics

The overwhelming majority of snacks today are in flexible bags. For snack food in the Indian market, a range of flexible materials are used depending on the product and the market segment.

Low value, typically traditional snack food and wafers may be branded or non-branded. Non – branded snacks are packed for shorter shelf-life in unprinted low density polyethylene (LDPE) and polypropylene (PP) pouches. For branded snacks and nuts laminated structures are used.

Some of the typical structures are:

- BOPP / LDPE
- BOPP / Polyester / LDPE
- Metallised Polyester / LDPE
- BOPP / Metallised Polyester / LDPE
- Polyester / LDPE
- Polyester / Al foil / LDPE (The sealant layer could also be LLDPE or cast PP)

In the European and American markets, the typical structures used for packaging of crisps and similar snack food are:

- PVDC coated glassine

- PVDC coated glassine / OPP
- Sulfite paper / OPP
- Co – extruded HDPE
- Oriented Polypropylene Films (uncoated, coated, co – extruded)
- LDPE / EVA films
- HDPE / EVA ionomer seal layer
- OPP / PE / PVDC coated OPP
- OPP / PE / metallised heat sealable OPP
- PVDC coated PET
- OPP / PVDC / OPP lamination

Biaxially oriented films are most widely used for snack food in Europe. OPP has qualities of toughness (against puncture and abrasion) and clarity and is rendered heat sealable by coextrusion with polyolefin copolymers or by coatings like PVDC.

3.4.2 Composite Containers

Composite containers are used for packaging of moulded chips and nuts. The containers are round and the body (side walls) is made of PE coated foil laminated spirally wound paper. The top and bottom ends of the containers may be made from metal or plastic. The bottom may also be made from PE coated foil laminated paper. An aluminium pull-tab top and re-closable plastic lid on the container form a complete pack.

A new process has recently been developed for composite packs, wherein the main body comprises of a composite material consisting of a light-weight high impact core of expanded polystyrene in the thickness range of 0.6 to 1.2mm. Externally the core is coated with a plastic film. The inner face is coated with a plastic film or a combination of film and aluminium foil, the function of these materials is to ensure optimum barrier properties against moisture, oxygen etc. A wide choice of films such as Polyester, PVDC or EVOH is available. The base, the lid and the snap-on re-closable caps are generally moulded from High Impact Polystyrene (HIPS) coated with polyester or other films to enhance the barrier properties. The base is solid moulding, whereas the lid incorporates a membrane which when pierced gives access to the product.

3.4.3 Tinplate Containers

Rigid, round tinplate containers, which are internally lacquered are used for roasted salted nuts that are packed with an inert gas like nitrogen for extended shelf-life. The containers are provided with ring pull type, easy open tops, fitted with re-closable plastic caps.

3.4.4 Other Plastics Packages

Other types of plastic packages less commonly used for roasted salts nuts are PET containers and injection moulded PET or PP trays with peelable lids.

3.4.5 Packaging Methods for Shelf – life Extension

The extension of shelf – life that can be achieved through inert gas flushing depends upon the product nature and the storage conditions. However, a reduced level of oxygen inside a package generally gives higher stability to rancidification. As stated earlier, three critical requirements for snack food packaging are moisture, oxygen and light barrier properties.

Snack food such as crisps have an initial moisture content (IMC) of 1 to 1.5% when packed. If this level reaches the critical moisture level (CMC) of 4-5%, the product becomes unacceptable. Crisps sold without nitrogen flushing in clear plastic pouches are said to have a short shelf-life owing to the high volume of air present in the pouches. To improve the shelf – life of these products, anti-oxidants are sometimes added in the oil used for frying. Flushing with an inert gas like nitrogen definitely increases the shelf-life, but until recently, was not used for low value products as it was claimed to be uneconomical.

Oxidative rancidity is accelerated by light, and therefore, light barrier properties are required in increasing the shelf-life. It has been reported that a potato snack product packaged in clear OPP film has a shelf – life (assessed by flavour and moisture changes) of only 8 to 10 weeks compared to over 26 weeks when packaged in metallised OPP film.

Flushing of potato crisps with nitrogen is said to have increased the shelf-life from about 60 days (without N2) to about 120 days (Anon., 1988). Another advantage of nitrogen flushing is that uniform pillow packs are produced, which prevent damage of the fragile snack products during handling and distribution.

Flushing with nitrogen is today commonly used to reduce residual oxygen in packs containing raw, fried and roasted cashew-nuts, pistachios, almonds, mixed nuts etc. The use of this technique has doubled or tripled the shelf - life of these products which ranges from 10-12 months. An alternative to gas flushing is the use of oxygen scavenger, which is said to be more effective than gas flushing for reducing the residual oxygen level within the packages, thereby further increasing the shelf-life of packaged nuts. Sachets containing the scavenger are placed inside the packs and have been found to reduce the oxygen level in airtight containers to 0.01% or less.

The other product, which has benefited when nitrogen flushed is popcorn. This product is packaged in a laminate of metallised PET / peelable PE.

The use of gas flushing has brought in improvements in barrier properties of packaging materials and in seal performance. Pouches made of metallised plastic films are increasingly used and are expected to grow for the packaging of snack food.

3.4.6 Development of New Generation Alternate Packaging System

The alternate packaging system essentially is a bag-in-box system comprising of an outer Corrugated Fibre Board (CFB) box with:

- An inner flexible multi-layered bag
- An inner semi-rigid plastic container (cubipack)

3.4.7 Bag-in-Box (Flexible System)

This system consists of a liner bag directly placed inside a corrugated fibre board box or the liner bag could be pasted inside a sleeve of corrugated fibre board, which is in turn pasted to the inner walls of the corrugated fibre board box. The liner bag could be flat pillow type or side gussetted. The CFB boxes (with liner bags) of 11.34 kg capacity (same size and shape as the traditional 18 litres tinplate containers) are to be filled with the product, vacuumised and then flushed with nitrogen gas and the liner bags are to be immediately heat sealed.

The boxes are to be closed by folding the flaps and the application of pressure sensitive tapes. Two such boxes are then placed in an outer transport CFB box, which is also to be closed by application of pressure sensitive tape. Two synthetic straps are used to reinforce the pack.

3.4.8 Bag-in-Box (Semi – rigid system)

This system consists of an inner semi-rigid collapsible container of LLDPE with an outer corrugated fibre board box.

Main Features of New Generation Alternate Packaging System

- ✓ The recommended packaging materials for the new packaging system are available globally.
- ✓ Adoption of the new packaging system does not involve major changes in the traditional filling system. Packaging machinery is available for vacuumising/nitrogen flushing and sealing the packages.
- ✓ The new alternate packages are lighter in weight as compared to traditional tinplate containers.
- ✓ The alternate packages are collapsible when empty and therefore storage requires less space.
- ✓ In the alternate packaging system, the materials used are eco-friendly and recyclable.
- ✓ The problem of lead solder has been overcome, so also the problem of sharp edges, making the system operator friendly, safe and hygienic.
- ✓ Economically beneficial by 10 -15% compared to traditional packaging.

Emerging trends in the snack food and ready-to-eat food market industry has given wide scope for development of a variety of innovative packaging media depending upon the required shelf-life and performance of wrapping machines. Plastic films and laminates are the most popular choice as a packing media, replacing traditional waxed paper and aluminium foil. Flexible plastics, composite containers and tinplate containers are commonly used for a variety of snack food packaging. Snack food industry has seen immense growth in the past few years. MNC's and large domestic companies venturing in local as well as international markets have led to innovative packaging solutions in plastics. The ability of plastics to pass all selection criteria as an effective packaging media has led to very high quantum of polymeric material being used in the snack food packaging industry.

CHAPTER 4

FSSAI STANDARDS AND FOOD SAFETY

4.1 FSSAI 6.3 Breakfast cereals, including rolled oats

Includes all ready-to-eat, instant, and regular hot breakfast cereal products. Examples include granola-type breakfast cereals, instant oatmeal, corn flakes, puffed wheat or rice or other cereals (puffed, pounded, popped) like poha, kheel, popcorn, multi-grain (e.g. rice, wheat and corn) breakfast cereals, breakfast cereals made from soy or bran, and extruded-type breakfast cereals made from grain flour or powder etc.

Food Category System	Food Category Name	Food Additive	INS No	Recommended maximum level	Note
*No additives permitted in Atta					
6.3	**Ready -to - eat cereals, breakfast cereals, including rolled oats**	**ASCORBYL ESTERS**		200 mg/kg	10
		Acesulfame Potassium	950	1,200 mg/kg	188
		Allura red AC	129	100 mg/kg	-
		Aspartame	951	1,000 mg/kg	191
		Curcumin	100	GMP	
		Paprika oleoresin	160c(i)	GMP	
		Brilliant blue FCF	133	100 mg/kg	
		Butylated	320	200 mg/kg	196, 15

		hydroxyanisole (BHA)			
		Butylated hydroxytoluene (BHT)	321	100 mg/kg	196, 15
		CAROTENOIDS		200 mg/kg	
		Caramel III - ammonia caramel	150c	50,000 mg/kg	189
		Caramel IV - sulfite ammonia caramel	150d	2,500 mg/kg	
		beta-Carotenes, vegetable	160a(ii)	400 mg/kg	
		Grape skin extract	163(ii)	200 mg/kg	
		IRON OXIDES		75 mg/kg	
		Neotame	961	160 mg/kg	
		Propyl gallate	310	200 mg/kg	196
		PHOSPHATES		2,200 mg/kg	33
		RIBOFLAVINS		300 mg/kg	
		SACCHARINS		100 mg/kg	
		Steviol glycosides	960	350 mg/kg	26
		Sucralose (Trichlorogalactos	955	1,000 mg/kg	

		ucrose)			
		Sunset yellow FCF	110	100 mg/kg	
		52**[TOCOPHEROLS**		**200 mg/kg]**	

4.2 Food Safety

Part I - General Hygienic and Sanitary practices to be followed by Petty Food Business Operators applying for Registration (See Regulation 2.1.1(2))

SANITARY AND HYGIENIC REQUIREMENTS FOR FOOD MANUFACTURER/ PROCESSOR/HANDLER

The place where food is manufactured, processed or handled shall comply with the following requirements:

1. The premises shall be located in a sanitary place and free from filthy surroundings and shall maintain overall hygienic environment. All new units shall set up away from environmentally polluted areas.

2. The premises to conduct food business for manufacturing should have adequate space for manufacturing and storage to maintain overall hygienic environment.

3. The premises shall be clean, adequately lighted and ventilated and sufficient free space for movement.

4. Floors, Ceilings and walls must be maintained in a sound condition. They should be smooth and easy to clean with no flaking paint or plaster.

5. The floor and skirted walls shall be washed as per requirement with an effective disinfectant the premises shall be kept free from all insects. No spraying shall be done during the conduct of business, but instead fly swats/ flaps should be used to kill spray flies getting into the premises. Windows, doors and other openings shall be fitted with net or screen, as appropriate to make the premise insect free The water used in the manufacturing shall be potable and if required chemical and bacteriological examination of the water shall be done at regular intervals at any recognized laboratory.

6. Continuous supply of potable water shall be ensured in the premises. In case of intermittent water supply, adequate storage arrangement for water used in food or washing shall be made.

7. Equipment and machinery when employed shall be of such design which will permit easy cleaning. Arrangements for cleaning of containers, tables, working parts of machinery, etc. shall be provided.

8. No vessel, container or other equipment, the use of which is likely to cause metallic contamination injurious to health shall be employed in the preparation, packing or storage of food. (Copper or brass vessels shall have proper lining).

9. All equipments shall be kept clean, washed, dried and stacked at the close of business to ensure freedom from growth of mould/ fungi and infestation.

10. All equipments shall be placed well away from the walls to allow proper inspection.

11. There should be efficient drainage system and there shall be adequate provisions for disposal of refuse.

12. The workers working in processing and preparation shall use clean aprons, hand gloves, and head wears.

13. Persons suffering from infectious diseases shall not be permitted to work. Any cuts or wounds shall remain covered at all time and the person should not be allowed to come in direct contact with food.

14. All food handlers shall keep their finger nails trimmed, clean and wash their hands with soap, or detergent and water before commencing work and every time after using toilet. Scratching of body parts, hair shall be avoided during food handling processes.

15. All food handlers should avoid wearing, false nails or other items or loose jewellery that might fall into food and also avoid touching their face or hair.

16. Eating, chewing, smoking, spitting and nose blowing shall be prohibited within the premises especially while handling food.

17. All articles that are stored or are intended for sale shall be fit for consumption and have proper cover to avoid contamination.

18. The vehicles used to transport foods must be maintained in good repair and kept clean.

19. Foods while in transport in packaged form or in containers shall maintain the required temperature.

20. Insecticides / disinfectants shall be kept and stored separately and `away from food manufacturing / storing/ handling areas.

4.3 LABELLING

Labeling Requirements

All food products sold in India that are prepackaged are required to comply with the Food Safety and Standards (Packaging and labelling) Regulations, 2011. The Food Safety and Standards Regulation, 2011 is a notification issued by the Food Safety and Standards Authority of India under the Ministry of Health and Family Welfare. In this article, we look at the regulations pertaining to food labelling in India.

Applicability of Food Labelling Regulations

The food labelling regulations require all “Prepackaged” or “Pre-packed food” to comply with the labelling regulations in India. As per the rules, prepackaged food means food, which is placed in a package of any nature, in such a manner that the contents cannot be changed without tampering it and which is ready for sale to the consumer.

General Labelling Requirements

The following labelling requirements must be complied with by all prepackaged food sold in India:

- The label must be in English or Hindi or Devnagri language. In addition to the above, the label can contain information in any other language, as required.
- The label must not contain information about the food that could be deemed to be false, misleading, deceptive or otherwise create an erroneous impression regarding the product.
- The label must be affixed to the container in such a manner that it would not easily be separated from the container.
- The contents or information presented in the label should be clear, prominent, indelible and readily legible by the consumer.
- If the container is covered by a wrapper, then the wrapper must contain necessary information or make the label of the product inside readily legible by not obscuring.
- The name of the food must be mentioned along with the trade name and description of the food contained. In case the food contains more than one ingredient, then a list of ingredients must be presented in descending order of

their composition by weight or volume, as the case may be, at the time of its manufacture;

Nutritional Information

Nutritional Information or nutritional facts per 100 gm or 100ml or per serving of the product must be given on the label along with the following information:

- energy value in kcal;
- the amounts of protein, carbohydrate (specify the quantity of sugar) and fat in gram (g) or ml;
- the amount of any other nutrient for which a nutrition or health claim is made:
- It is important to note that any “health claim” or “nutrition claim” or “risk reduction” claim made in the label will be thoroughly scrutinized by the FSSAI authorities. Hence, any such claim must be validated by test data. As per the rules, the following is the definition for “health claim”, “nutrition claim” and “risk reduction” claim:
- “Health claims” means any representation that states, suggests or implies that a relationship exists between a food or a constituent of that food and health and include nutrition claims which describe the physiological role of the nutrient in growth, development and normal functions of the body, other functional claims concerning specific beneficial effect of the consumption of food or its constituents, in the context of the total diet, on normal functions or biological activities of the body and such claims relate to a positive contribution to health or to the improvement of function or to modifying or preserving health, or disease, risk reduction claim relating to the consumption of a food or food constituents, in the context of the total diet, to the reduced risk of developing a disease or health-related condition;
- “Nutrition claim” means any representation which states, suggests or implies that a food has particular nutritional properties which are not limited to the energy value but include protein, fat carbohydrates, vitamins and minerals;
- “Risk reduction” in the context of health claims means significantly altering a major risk factor for a disease or health-related condition;

Veg or Non-Veg Symbol

All packaged food that is “Non-Vegetarian” must have a symbol that is a brown colour filled circle inside a square with a brown outline. If a food contains only egg as a non-vegetarian ingredient, then the manufacturer may provide a declaration that the product contains only egg and add the non-vegetarian symbol.

Non-Veg Symbol

Packaged vegetarian food should have a symbol that consist of green colour filled circle inside a square with green.

Veg Symbol

Information Relating to Food Additives, Colours and Flavours

Food additives contained in the food product must be mentioned along with class titles along with the specific names or recognized international numerical identifications. Addition of colouring matter should be mentioned on the label along with certain statements like “CONTAINS PERMITTED NATURAL COLOUR(S)”, just beneath the list of the ingredients on the label. In case of addition of extraneous flavouring agent, then it should be mentioned in a statement like “CONTAINS ADDED FLAVOUR” just beneath the list of ingredients on the label.

Name and Complete Address of the Manufacturer

The name and complete address of the manufacturer must be mentioned on every package of food. In the case of imported food, the package must contain the name and complete address of the importer in India.

Net Quantity

All packaged food must carry the bet quantity by weight or volume or number, as the case may be. The net quantity of the commodity contained in the package must exclude the weight of the wrappers and packaging materials.

Lot Number of Batch Identification

A lot number or batch number or code number must be mentioned on all packaged food so that it can be traced while manufacturing and distribution. Only bread and milk including sterilised milk are not required to comply with this regulation.

Date of Manufacture or Packing

The date, month and year in which the commodity is manufactured, packed or pre-packed must be mentioned on the label. In the case of food products having a shelf life of more than three months, then the month and the year of manufacture can be given with the "Best Before Date". In case of products having a shelf life of fewer than three months, the date, month and year in which the commodity is manufactured or prepared or pre-packed must be mentioned on the label with best before date.

Country of Origin for Imported Food

For imported food, the country of origin of the food should be declared on the label of the food. In case a food product undergoes processing in a second country which changes its nature, the country in which the processing is performed should be considered to be the country of origin for the purposes of labelling.

Instructions for Use

Instructions for use, including reconstitution, should be included on the label, if necessary, to ensure correct utilization of the food.

Contact Us

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