PM Formalisation of

Micro Food Processing Enterprises Scheme

HANDBOOK OF

PROCESSING OF COFFEE POWDER

AATMANIRBHAR BHARAT

Indian Institute of Food Processing Technology

Ministry of Food Processing Industries, Government of India
Pudukkottai Road, Thanjavur
Tamil Nadu

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Coffee was allegedly born before 1,000 A.D. when legend has it that a shepherd named Kaldi, in Caffa, Ethiopia noticed that his sheep became hyperactive after grazing on some red berries. Coffee was first introduced in Turkey during the Ottoman Empire around A.D. 1453 and coffee shops opened to the public. Coffee came to India via Mysore in Karnataka, brought secretly by a Sufi Saint from Meccan named Baba Budan.Coffee is pleasure. Its taste, flavour, aroma and refreshing effect makes it unique.

Green coffee: A green coffee bean is a commercial term which designates the dried seed of the coffee plant. It has about 10.0% moisture. Coffee plant or tree belongs to Coffea genus.

World major coffee players

1) Starbucks corporation
2) The Kraft Heinz company
3) The coca cola company
4) Tata global beverages
5) Nestle SA
6) JM Smucker company
7) JAB Holding company
8) Luigi Lavazza SPA

1.2 CLASSIFICATION OF GREEN COFFEE BEANS

Two species are commercially important for green coffee:

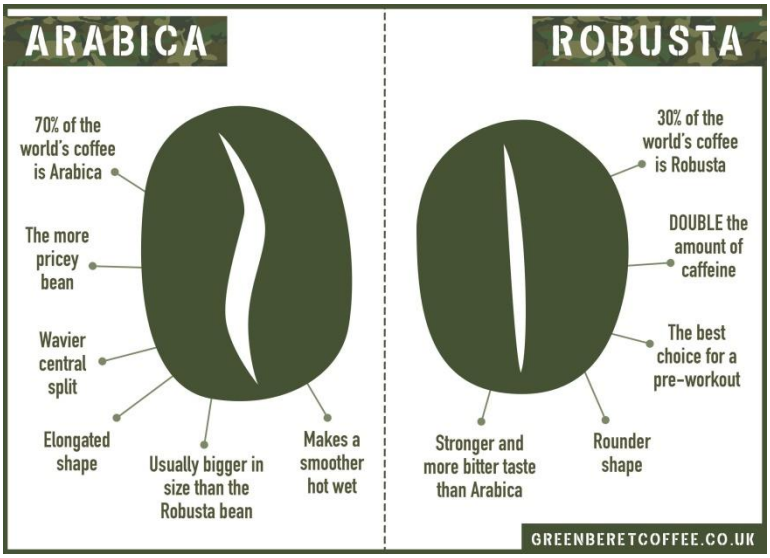
- *Coffea canephora* (also referred to as *C. robusta*)
- *Coffea arabica L.*

Arabica accounts for 75% of global coffee production.

Arabica coffee bush bears about 5 kg fruit per year which corresponds to 300-400g of Instant coffee. Robusta bushes yield slightly higher.

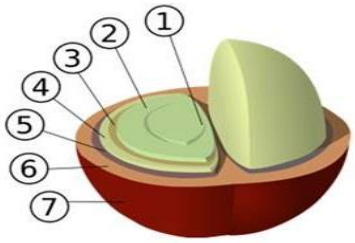
Comparison of *C. robusta* with *C. arabica*

- Flavour quality (roasted and brewed) is generally considered to be inferior for *C. robusta.*
- Less expensive per unit weight of green coffee.
- Characteristics found favourable in manufacture of some instant coffees
- Often features in Espresso coffee.
- Consumed as regular brewed coffee.
- Arabica has more aroma. Robusta contains more caffeine and is consequently slightly bitter.



Indian coffee is the most extraordinary of beverages, offering intriguing subtlety and stimulating intensity. India is the only country that grows all of its coffee under shade. Typically mild and not too acidic, these coffees possess an exotic full-bodied taste and a fine aroma.India's coffee growing regions have diverse climatic conditions, which are well suited for cultivation of different varieties of coffee. Some regions with high elevations are ideally suited for growing Arabicas of mild quality, while those with warm humid conditions are best suited for Robusta's.

1.3 STRUCTURE OF COFFEE BEAN



1. Center cut
2. Bean (endosperm)
3. Silver skin(testa, epidermis)
4. Parchment(hull, endocarp
5. Pectin layer
6. Pulp (mesocarp)
7. Outer skin (pericarp, exocarp)

When the fruit is ripe, it is almost always handpicked, using either selective picking, where only the ripe fruit is removed or strip-picking, where all of the fruit is removed from a branch all at once. Because a tree can have both ripe and unripe berries at the same time, one area of crop has to be picked several times, making harvesting the most labor intensive process of coffee bean production.There are two methods of processing the coffee berries. The first method is **wet processing**, which is usually carried out in Central America and areas of Africa. The flesh of the berries is separated from the seeds and then the beans are fermented soaked in water for about 2 days. This dissolves any pulp or sticky residue that may still be attached to the beans. The beans are then washed and dried in the sun, or, in the case of commercial manufacturers, in drying machines.The **dry processing** method is cheaper and simpler, used for lower quality beans in Brazil and much of Africa. Twigs and other foreign objects are separated from the berries and the fruit is then spread out in the sun on cement or brick for 2-3 weeks, turned regularly for even drying. The dried pulp is removed from the beans afterward.After processing has taken place, the husks are removed and the beans are roasted, which gives them their varying brown color, and they can then be sorted for bagging.

1.3.1 CHEMICAL COMPOSITION OF COFFEE BEAN

Component	Arabica coffee
Polysaccharides	49.8
Sucrose	8.0
Reducing sugars	0.1
other sugars	1.0
Lipids	16.2
Proteins	9.8
Amino acids	0.5
Aliphatic acids	1.1
Quinic acids	0.4
Chlorgenic acids	6.5
Caffeine	1.2
Trigonelline	1.0
Minerals (as oxide ash)	4.2
Volatile aroma	traces
Water	8 to 12

1.3.2 ORGANIC COFFEE

Organic coffee are those produced by such management practices which help to conserve or enhance soil structure, resilience and fertility by applying cultivation practices that use only non-synthetic nutrients and plant protection methods. Further, there has to be credible certification by an accredited certification agency.Organic coffee is being produced by about 40 countries in the world with major production share coming from Peru, Ethiopia and Mexico. Organic coffee is chiefly consumed in the Europe, US and Japan. Organic coffee products are now marketed in the form of regular, decaffeinated, flavoured and instant coffee as well as in other foods like ice creams, yoghurt, sodas, candies and chocolate covered beans, etc.

CHAPTER 2

PROCESSING OF COFFEE POWDER

2.1 GREEN BEAN PROCESSING

Green bean itself has no comestible value for humans and must be roasted before use as a flavourful and stimulant aqueous beverage.Green coffee beans are dried, cleaned and packed usually in 60 kg bags and stored before they are roasted.

2.1.1 COFFEE PROCESSING

The green bean has no comestible value for humans and must be roasted before use for developing the desired colour and flavor, enjoyed as a stimulant beverage.

Three methods of coffee processing

1) **DIRECT DRYING PROCESS**

The coffee cherries are dried immediately after harvest. This is usually sun drying on a clean dry floor or on mats. The bed depth should be less than 40mM. The cherries should be raked frequently to prevent fermentation or discoloration.

2) **SEMI- DRYING PROCESS**

The Coffee beans are washed, thus keeping the protective mucilage on the bean. As the mucilage has a lot of sugar this produces very sweet coffee with beautiful honey qualities. The beans can literally ooze this substance during the drying process.

3) **WET PROCESS (Parchment process)**

Cherry is squeezed in a pulping machine or pestle and mortar which removes the outer fleshy material (mesocarp and exocarp) leaving a bean covered in mucilage. The mucilage is removed.The bean is washed and dried.

2.1.2 PREHARVESTING OF COFFEE

CROP CALENDAR

Picking of coffee fruit

- Fully ripened red fruits should be harvested.
- Immature fruit results in loss of flavour.
- Over ripen fruits undergoes fermentation during processing and imparts unpleasant aroma.

Picking is manually either by selective or mechanical stripping method.

2.1.3 ROASTING PROCESS

It is a time-temperature dependent process, whereby chemical changes are induced by pyrolysis within the coffee beans, together with marked physical changes in their internal structure. The required change takes place with a bean temperature from 190◦C upwards; bean temperature up to 240◦C may be reached in less than 12 minutes.Batch operated horizontal rotating drum roaster with either solid or perforated walls, in which hot air from a furnace/burner passes through the tumbling green coffee beans. Green coffee beans under movement are subjected to heat by conduction from hot metal surfaces, or convection from hot air, or more generally a mixture of both methods of heat transfer, together with contribution by radiation.A

typically sized roaster holds 240 kg of green coffee, with an outturn (charging to discharging) of 15 min. The furnace or burner will be either oil or gas fired.

Other roasters include:

- Vertical static drum with blades
- Vertical rotating bowl
- Fluidized bed
- Pressure roasting

The latest roasters have shorter roast times i.e. of the order of 3-5 min. Fast-roasted coffee is advantageous because of lower bulk density and high yieldon brewing.The degree of roast may vary from Very light to very dark.Consumer preference is usually medium roast.

2.2 PHYSICO-CHEMICAL CHANGES IN COFFEE

Chemical changes

The chemical changes include Maillard type reactions and caramelization of sucrose. The composition of roasted coffee is furnished.Volatile complex comprising of furan derivatives, pyrazines, pyridines, benzenoid aromatics, aliphatics, alicyclics and various sulphur compounds. These are important for the flavour/aroma in medium-roast Arabica coffee.Some compounds are generated by straight pyrolysis of single compounds e.g. chlorogenic acids in generating phenols; there is overall 40% residual content for a medium roast. The change in chlorogenic acid content is used as analytical measure of degree of roast.Similarly, coffee oil leads to formation of small amounts of aldehydes and hyrdrocarbons. The coffee oil is practically unaffected, as is the caffeine content.Newly formed residuum of ~ 25% by weight of roasted coffee is melanoidins/humic acids. The loss of mass is 2-3% on dry basis for Light roast, whereas it is up to 12% on dry basis for Very dark roast. The beans lose 15-20% of their weight, but increases up to 25% in size.

Physical changes

The physical changes that occur include:

- Change in colour.
- Formation of cavities/cracking of surface.

- Void volume is 47% of **medium roast bean** vs. 0% in **Cooling**

COOLING

In batch operation, the roasted beans have to be quickly discharged at the end of required roasting period into a cooling car, or vessel, allowing upward passage of cold air.In addition, water may be sprayed from within the rotating drum, just before the end of the roast so called Water quenching.Assists in necessary cooling. Adds a small percentage of water by weight to roasted beans, thereby assists uniformity of particle size in subsequent grinding.

2.2.1 Composition of roasted coffee

Component	**Typical average content for (%)**	
	Arabica	**Robusta**
Alkaloids (caffeine)	1.3	2.4
Trigonelline (including roasted byproducts)	1.0	0.7
Proteinaceous		
Protein	7.5	7.5
Free amino acids	0	0
Lipid(Coffee oil with unsaponifiable)	17.0	11.0
Sugars:		
Sucrose	0	0
Reducing sugars	0.3	0.3
Polysaccharide(unchangefrom green)	33.0	37.0
Lignin	3.0	3.0
Pectins	2.0	2.0
Acids:		
Residual chlorogenic	2.5	3.8
Quinic	0.8	1.0
Aliphatic	1.6	1.6
Minerals (oxide ash)	4.5	4.7
Caramelized/condensation products (Melanoidins, etc.)	25.5	25.5
Total	100.0	100.0

Grinding

Multistage twin horizontal rollers up to 4 stages may be used to ensure more uniform particle size distribution.

1st and 2nd stages Essentially performs cracking or crushing the beans into smaller units.

3rd and 4th stages Leads to progressively finer grinding.

The grind size required is related to subsequent method of brewing to be adopted and whether for home use or subsequent large scale extraction i.e. coarse, medium, fine, very fine.

Grind size of roasted and ground coffee beans

Grind size	Actual size (micro meter)
Fine grind	430 (Europe), 800 (USA)
Coarse grind*	850 (Europe), 1130 (USA)

* for household percolators

The number of different screen sizes numbered by aperture size within the range of 1400 micro meter to 250 micro meter. Newer method performs sizing by laser beams.

2.2.2 PACKAGING

Roasted and ground (R & G) coffee releases substantial quantities of entrapped CO_2 gas which develops high internal pressure, leading to bursting of package. The usual packaging material is laminates.

Packaging under vacuum

It allows a low percentage of oxygen content in headspace to be established within the package and accommodate release of CO_2. Alternatively CO_2 scavenger may be used.

Degas over a sufficient time period

The R & G coffee is allowed in bulk to degas over a sufficient time period to a low level, followed by gas purging whilst individual packages are being filled.

Gas purging is used to ensure that the residual oxygen in headspace is below 1.0%.

In Europe, use of plastic packages to which a non-return valve is securely attached allows release of excess CO_2, when internal pressure exceeds a certain predetermined level.

Extraction

- Fast instant coffee extractors (FIC)
- Conventional batch percolators
- Continuous counter current extractors (CONTEX)

FIC extraction unit

It reduces extraction time by 50% compared to batch percolators. Water is directed through the ground coffee in two stages. The process results in two completely separated extract fractions viz., aroma and hydrolysis. After extraction, the extract is filtered and centrifuged.

Extraction treatment

- Aroma recovery
- Clarification

Clarification

It is a system consisting of filters and centrifuges to separate insoluble parts from the extract to achieve international standards.

Concentration

- Falling film and plate evaporators
- Freeze concentration
- Membrane filtration systems

Concentration: It serves to increase the solids content in extract prior to freeze or spray drying.

a) **Thermal concentration :**

Multistage non-recirculating evaporators operating under vacuum in a plug flow mode.

b) Membrane filtration

The aroma fraction of the extract can be pre-concentrated using reverse osmosis in a membrane filtration system.

c) Freeze concentration :

By cooling the extract to subzero temperatures, excess water is removed as ice crystals. Freeze and thermal concentration, membrane filtration, Falling film and plate evaporators are used for the purpose of concentration.

Drying

- Nozzle Tower spray dryer
- Fluidized bed spray dryer
- Continuous freeze dryers (CONRAD)
- Batch freeze dryers (RAY)

Domestic and Catering Methods of Brewing

Brewing is extraction of soluble substances contributing to the basic taste plus of volatile substances for overall flavour. Roast coffee must be ground before brewing.

The two main mechanical principles are:

Steeping/ Slurrying of R & G coffee with water, with or without agitation, followed by sedimentation or filtration or both. **Percolation** in fixed beds of R & G coffee held in an open or closed container. Water may be passed through either in a single pass under gravity or under pressure (including steam, as in Espresso making), or in a multipass.

Extraction

Extraction of coffee solids can be carried out by

- Fast instant coffee extraction
- Conventional batch percolators.
- Continuous countercurrent extractors.

Factors in Brewing

- Coffee-to-water weight ratio
- The appliance used for brewing.
- The temperature employed.

Of the components of roasted coffee, only some will be extracted completely with variable amounts of the others to reach ~ 28% w/w total maximum and 21% optimum under household brewing conditions, by hot or boiling water so called yield.

Mechanical operation involved is a means of separating the undesired so-called Spent coffee grounds from the required brew formed by sufficient contact with water. The brew should contain as little of spent ground particles as possible and must be presented hot (i.e. 50-55◦C).

Flavour Quality of Coffee Brew

The factors determining flavour quality of brew include:

- The choice of blend used.
- The degree of roast.
- Brewing conditions.

2.3 Coffee brewing methods

- Expresso method
- Fresh brew method
- Instant coffee
- Quick filter method
- Percolator

2.3.1 Expresso method

Coffee, an espresso machine has to be used. This machine is passing hot water through the ground coffee at a pressure of around 9 bar. The coffee is particularly finely ground. The result is a spicy coffee with a closed cream layer.

2.3.2 Fresh brew method

It is based on a quick filter method.With a fresh brew machine, the extraction process is accelerated and a stainless steel permanent filter is used.

2.3.3 Instant

Instant coffee is produced by so-called freeze-drying freshly brewed strong coffee. Coffee is quick and easy to prepare, simply by adding hot water. This gives you a cup of coffee in no time.

2.3.4 Percolation

The coffee is placed in a metal filter at the top of percolator.The hot water underneath rises through a tube and seeps through the coffee.Longer percolation time gives strong coffee.

2.3.5 Quick filter

Classic way of making coffee.Used for making small and large amounts of coffee.

2.3.6 FILTER

Choice of grind.South Indian Coffee, also known as Filter Coffee is a sweet milky coffee made from dark roasted coffee beans (70-80%) and chicory (20-30%), especially popular in the southern states of Tamil Nadu and Karnataka. The most commonly used coffee beans are Arabica and Robusta.

Outside India, a coffee drink prepared using a filter may be known as Filter Coffee or as Drip Coffee as the water passes through the grounds solely by gravity and not under pressure or in longer-term contact.

South Indian metal based coffee filter

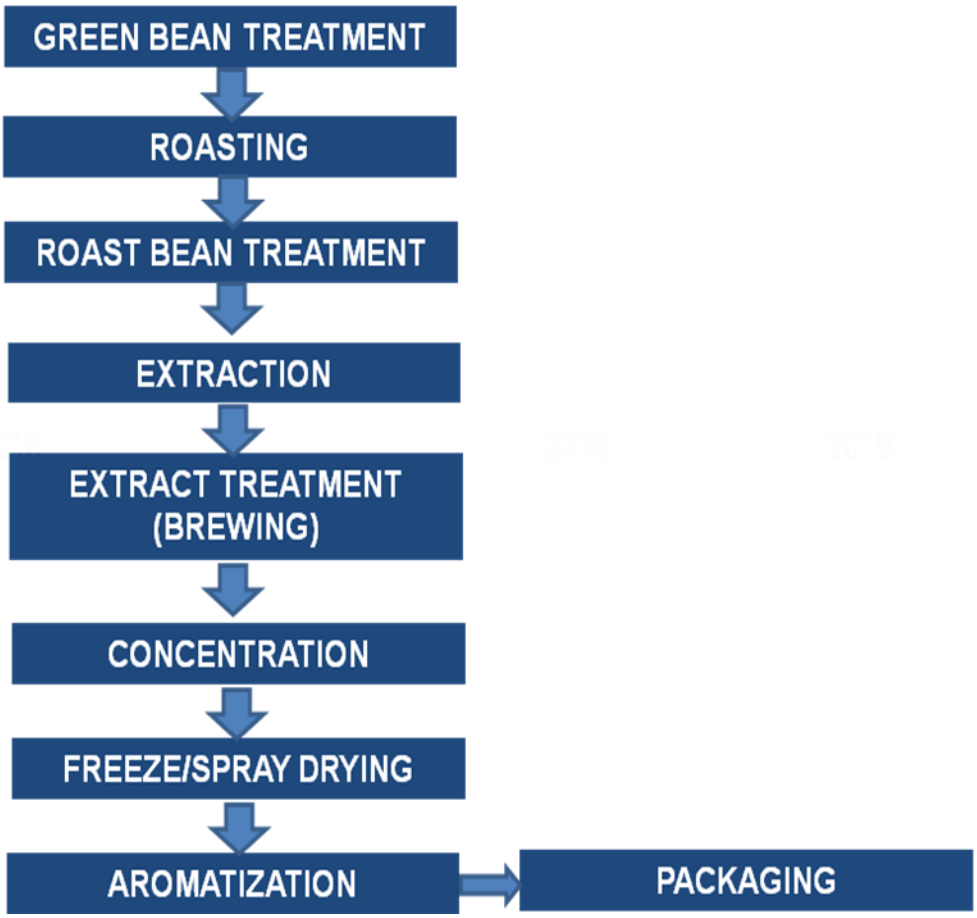
2.3.7 Aromatization of Coffee

It is a term applied to a process, whereby essentially the headspace coffee aroma volatiles are made available by plating coffee aroma oil, prepared by expression methods from roast coffee, or other sources onto the soluble coffee, usually at the packing stage. This is a treatment imparted to improve the flavour and aroma. The powder lacks full flavour and aroma of freshly brewed coffee. The flavour and aroma constituents are trapped and recovered during roasting, grinding and extraction and from oils pressed from coffee bean. The cold CO_2 does not damage the flavour and aroma compounds in coffee oil and it is easily separated from extracted oil for recompression and reuse.After CO_2 removal of the oil, the Roasted and Ground coffee is still highly suitable for extraction of water soluble solids in the regular extraction battery operation.

2.3.8 Aroma recovery

The extract fractions are stripped of their volatiles in an aroma recovery unit. After being stripped from the concentrate in a flash evaporator, the aroma is recovered in a 2-stage condenser system.

2.3.9 INSTANT COFFEE



Instant coffee, also called **soluble coffee** and **coffee powder**, is a beverage derived from brewed coffee beans. It is the dried soluble portion of roasted coffee, which can be presented to the consumer in either powder or granule form for immediate make-up in hot water. Instant coffee is commercially prepared by either freeze-drying or spray drying, after which it can be rehydrated.Instant coffee was invented in 1901 by Satori Kato, a Japanese scientist working in Chicago.Historically, most instant or soluble coffees first contained added carbohydrates (~ 50% w/w) such as corn syrup solids, as simple aqueous extract of roasted coffee, extracted under atmospheric conditions (100◦C). However, it could not be spray dried to a satisfactorily free-flowing low-hygroscopic powder.In 1950, Instant coffee of 100% pure coffee solids became commercially available. In 1965, Instant coffee in soluble form, somewhat darker in colour and improved retention of aromatics became available.The manufacture of instant coffee is accompanied by some slight hydrolysis of the polysaccharides in the roasted coffee (by further aqueous extraction at temperatures up to 175◦C and addition to the simple extract before drying),

which is reflected in the slightly increased reducing sugar content (i.e. arabinose, mannose and galactose) and probably assists solubilization of these polysaccharides, not otherwise easily possible at 100◦C. This provides a powder of satisfactory physical properties.Advantages of instant coffee include speed of preparation (instant coffee dissolves instantly in hot water), lower shipping weight and volume than beans or ground coffee (to prepare the same amount of beverage), and long shelf life.About 20% of all processed coffee beans are used for making Instant coffee. The capacity of the plant available is up to 500 kg of Instant coffee per hour.

2.4 CLASSIFICATION OF INSTANT COFFEE POWDER

2.4.1 Non-agglomerated instant coffee powder

This type of powder consists of individual spherical bead-like particles giving the powder its free-flowability and good solubility in hot water. It is most economically produced in spray dryers with tower drying chambers. Powder bulk density is adjusted through inert gas injection into the concentrated coffee extract prior to high pressure atomization.

2.4.2 Agglomerated instant coffee powder

This type of powder consists of either medium-sized or large agglomerates with a minimum of fines, giving the powder superior free-flowability and solubility in hot and cold water. Medium sized agglomerates are most economically produced in spray bed dryers incorporating fluid bed agglomeration within the drying chamber. Large agglomerates are produced in a powder agglomerator where spray dried instant coffee is rewetted and dried, under strictly controlled conditions.

2.4.3 Granulated instant coffee powder

This type of powder consists of large granules, free from fine particles that gives the powder excellent free-flowability and solubility in hot water. It is most economically produced in freeze dryers, where the low temperature drying environment maximizes aroma retention. The size of the granules is determined by the degree of size reduction and size classification applied to the frozen extract.

2.4.4 Production Method for Instant Coffee

As with regular coffee, the green coffee bean itself is first roasted to bring out flavour and aroma. Rotating cylinders containing the green beans and hot combustion gases are used in most

roasting plants. When the bean temperature reaches 165◦C the roasting begins, accompanied by a popping sound. These batch cylinders take about 8◦C 15 min to complete roasting with about 25-75% efficiency. Coffee roasting using a fluidized bed only takes from 30 sec to 4 min, and it operates at lower temperatures which allow greater retention of the coffee bean aroma and flavor. The yield of soluble solids from roasted coffee is presented in Table 33.1.

Yield (on dry basis) of soluble solids from roasted coffee

Conditions	Yield (on dry basis)
Brewed coffee	21.0% w/w
Exhaustive extraction at 100°C	Up to 32.0% w/w
Instant coffee	40.0-55.0% w/w

The beans are then ground finely. Grinding reduces the beans to 0.5-1.1mm (0.020-0.043 in) pieces in order to allow the coffee to be put in solution with water for the drying stage. Sets of scored rollers designed to crush the beans.Once roasted and ground, the coffee is dissolved in water, referred to as extraction. Water is added in 5-10 percolation columns at temperatures of 155-180◦C; this concentrates the coffee solution to about 15-30% coffee by mass. This may be further concentrated before the drying process begins by either vacuum evaporation or freeze concentration.

Although freeze drying is expensive, it generally results in a higher-quality product.

2.5 Drying Techniques

2.5.1 Spray drying

Spray drying is the most economic method to obtain soluble coffee which is free-flowing and agglomerated/granulated powders. The dried powder has about 3.0% moisture.Spray drying features the spraying (atomization) of concentrated extract into hot drying air. The spray droplets dry to form a non-agglomerated, free-flowing powder consisting of large individual spherical bead-shaped particles. An agglomerated powder with low fines content can be produced by combining spray drying with powder fluidization in an integrated fluid bed built into the spray drying cone base. Powders consisting of very large agglomerates are produced in a separate agglomeration process, in which spray dried powder is rewetted by steam, agglomerated, and

dried using fluidization and cascading powder principles.Spray drying produces spherical particles about 300micrometer (0.012 in) size with a density of 0.22 g/cm. To achieve this, nozzle atomization is used. High speed rotating wheels operating at speeds of about 20,000 rpm may be used. The use of spray wheels requires that the drying towers have a wide radius to avoid the atomized droplets collecting onto the drying chamber walls. The drying is completed in 5-30 sec. (dependent on factors such as heat, size of particle, and diameter of chamber). The inlet and outlet air temperature are typically 270◦C and 110◦C respectively. The moisture content of the feed and powder is 75-85% and 3-3.5% respectively.Spray drying is preferred to freeze drying in some cases because of its economy, short drying time, usefulness when dealing with heat-sensitive product, and the fine, rounded particles it produces.One drawback with spray drying is that the particles it produces are too fine to be used effectively by the consumer; they must first be either steam-fused in towers similar to spray dryers or by belt agglomeration to produce particles of suitable size.

2.5.2 Nozzle tower spray dryer

It gives a free-flow powder with average particle size of 100-250micro meter; however the residence time in dryer is longer.

2.5.3 Fluidized spray dryer

It gives a free flow agglomerated/granulated coffee. The powder has average particle size of 100-300 micro meter. Lower drying temperatures are employed with improved aroma in powder.

2.5.4 Filtermat spray dryer

This employs even lower temperature and longer drying times. It yields coarse, agglomerated/granulated, free-flowing and dustless powder with particle size of 250-1000 micro meter and with increased aroma retention.Nozzle tower, Fluidized spray dryer, Filtermat spray dryer, Freeze dryers may be utilized for drying purpose.Certain important criterion that needs to be controlled in drying technology includes:

- Colour (brightness) of the final soluble coffee powder
- Particle size distribution and powder structure / morphology
- Bulk density
- Residual moisture content

- Aroma retention
- Flowability
- Solubility
- Mechanical stability

The latest technology in vogue in spray dryers are the air disperser and drying chamber designs that enable production of powder having the desired particle morphology and taste through enhanced retention of desirable aromatic volatiles.

The Spray dryer coupled with extract concentrate gas injection and dosing unit installed on the high pressure side of the spray dryer feed line represents the latest design concept in the important area of powder bulk density control and coffee powder brightness.

2.5.5 Agglomerated Powder

Powder is processed in Rewet Agglomerator to obtain dustless powder and customized granules. The average particle size obtained is > 1000 m.

2.5.6 Freeze Drying

Freeze drying gives a premium product. It preserves all the desirable aspects of the concentrated coffee extract. Actual freezing can take place on a continuous Air blast belt freezer or for smaller capacities on Rota drum freezer. Granulation of frozen coffee slabs is done to get the right granule size and size distribution.

Quality parameters include colour, density and solubility.

Freeze drying includes pre-freezing, foaming and freezing of the concentrated extract followed by granulation - sieving of the frozen granules, which are dried in trays (batch processing) or on a moving conveyer belt (continuous processing).

On freezing, the water in the concentrated extract forms ice crystals, which sublime underthe influence of vacuum and applied heat to leave a dry granular product. Sublimation is the direct phase transition from solid state (ice) to gas phase (vapour). The conveyer belt permits much shorter drying times, promoting improved aroma retention as the coffee granules are exposed only for a relatively short time, to the vacuum conditions inside the freeze drying sublimation chamber

CHAPTER 3

PACKAGING OF COFFEE POWDER

Food packaging is the enclosing of food for the purpose of protection and preservation.Coffee is an extremely consumer-driven product.Packaging is one of the most important factors driving sales, food identity and brand construction. Package role is to preserve the freshness of coffee and attractive design for marketing and branding.

The quality of food powders is based on a variety of properties, depending on the specific application. In general, the final moisture content, insolubility index, dispersability index, free fat, rheological properties, and bulk density are of primary importance. These characteristics depend on drying parameters (type of spray dryers, nozzles/wheels, pressure, agglomeration, and thermodynamic conditions of the air: temperature, relative humidity, and velocity) and characteristics of the concentrate before drying (composition/physicochemical characteristics, viscosity, thermo-sensibility, and availability of water).

3.1 Need of coffee packaging

In addition to protection and preservation –

- ❑ Maintenance of the food's shelf life
- ❑ Containing the foods
- ❑ Providing information about the ingredients and
- ❑ Nutritional aspects of its contents
- ❑ Providing convenience for customers during usage and consumption
- ❑ Prevention from environmental damages.

Deteriorative reactions and indices of failure

- Cohesion/flowability
- Caking
- Maillard reactions
- Lipid oxidation
- Water activity
- Temperature
- Oxygen
- Light

3.2 IMPACT OF PACKAGING ON INDICES OF FAILURE

3.2.1 MOISTURE TRANSFER

Absorption or desorption of moisture can significantly affect the shelf life of foods. This is particularly the case for dry, powdery products such as coffee powders. The main purpose of packaging is to protect the powder from moisture ingress to preserve the product characteristics. When they gain moisture, powdery products become lumpy or cake. In addition, the moisture may lead to deleterious changes such as structural transformations, enzymatic reactions, browning, and oxidation, depending on temperature and the availability of O_2. Moisture or water vapour ingress in combination with light, O_2, and an elevated temperature can result in physical loss of texture and caking due to lactose crystallization, microbial spoilage, non-enzymatic reactions (such as Maillard browning), and fat oxidation.

3.2.2 OXIDATION

A number of food components react chemically with O_2, affecting the color :flavour, nutritional status, and occasionally the physical characteristics of foods. In some cases, the effects are deleterious and reduce the shelf life of the food; in others they are essential to achieve the desired product characteristics. Packaging is used to exclude, control, or contain O_2 at the level most suited for a particular product. It is therefore not surprising that to prevent oxidation of coffee powder; the packaging should provide a high-level O_2 barrier and be able to retain that barrier during the anticipated shelf life. Gas :flushing with a chemically inert gas such as N_2 may be essential to replace O_2 present in the package before closing. Most of the common spoilage bacteria and fungi require O_2 for growth. Therefore, to increase the shelf life of foods, the internal package atmosphere should contain a minimum concentration of residual O_2.

3.2.3 LIGHT

Light- induced degradation reactions in coffee create a serious problem for the dairy industry because of the development of off flavours, the decrease in nutritional quality, and the rate at which these phenomena develop. Packaging materials that can provide a barrier to light are essential to avoid this particular deteriorative reaction in coffee products. As mentioned earlier, light in combination with O_2 and moisture affects the quality of coffee powder, and therefore light ingress via the package should be avoided. A package with a high barrier to the transmission of visible and invisible wavelengths is important. Therefore, packaging materials that are highly opaque are essential.

3.3 Shelf life of coffee powders in different packages

Shelf life is defined as the period between production and the time the food item loses its state of safe and satisfactory quality in terms of nutritional value, microbial status: flavour,

texture, and appearance. The packaging plays a fundamental role in maintaining the quality and therefore the shelf life of foods. The package is an integral part of the preservation system and functions as an interface between the food and the external environment; the package should be designed and developed not only to contain the food product but also to protect it and add value to it, as its design may directly affect the purchase decision of the consumer.

For retailing to consumers, coffee powder is packed into either metal cans or multilayer pouches. The type and construction of the package depends on the type of coffee powder (the surface area:volume ratio of the package, the desired shelf life, the ambient storage and transport environment, and the anticipated market environment. WMP, for example, is often packed under N_2 gas to protect the product from fat oxidation, maintain its :flavour, and extend shelf life. Packaging performance specifications therefore vary and depend on variations in product characteristics, the ambient distribution environment, and the market environment.

Essentially, packaging systems for coffee powder must protect the powder from exposure to moisture, O_2, and light and anticipate the likely external environmental factors, which include temperature, time, relative humidity, light, and physical hazards.

3.3.1 METAL CANS

Packaging coffee powder in metal cans has been highly popular for a long time, particularly for retail packaging. For example, cans are commercially available with capacities of 400, 900, 1800, and 2500 g. The main reason for using metal cans is their excellent physical strength, durability, absolute barrier properties to moisture, O_2, and light, absence of flavour or odour, and rigidity.

3.3.2 MULTILAYER POUCHES

In recent years, aluminium foil/plastic film laminates have been introduced as a replacement for the tinplate can. The laminates can be formed, filled, gas-flushed, and sealed on a single machine from reel stock. Such flexible pouches or sachets are well positioned to exploit the opportunities for convenience food markets. Flexible packages reduce the volume of traditional packaging such as metal cans, reduce transport costs, reduce the cost of the packaging, and require less material, thus minimizing postconsumer waste.

Commonly, a laminated multilayer pouch for coffee powder must comprise a barrier to water vapor, O_2 (at least for WMP products), and light. Aluminium foil is capable of providing such a barrier provided the foil does not have pin holes in it. Aluminium foil built into a flexible material provides a close-to-absolute barrier. Building into a flexible material is essential because the foil does not have any mechanical strength by itself and therefore needs protection from mechanical damage.

A sandwich construction with two plastic layers—one on the inside, such as low density polyethylene (LDPE), so that the pouch can be sealed and one on the outside, such as biaxially oriented polypropylene (BOPP) or poly(ethylene terephthalate) (PET), to provide mechanical protection and also carry information—is common practice.

Sachets with larger capacity (in excess of 250 g) comprising a high-barrier plastic layer sandwiched between LDPE and BOPP or PET would be able to achieve a similar shelf life to an alufoil-sandwiched portion pack pouch.

3.4 Types of packaging material used for coffee powder

1. **Roasted and Ground coffee -** Tin-plate, Glass, Plastic films or foil, Laminated pouches of paper/LDPE, PET/LDPE,BOPP/LDPE.
2. **Soluble coffee powder -** Tin-plate or glass container, Flexible laminated pouches ofpaper/LDPE, PET/LDPE, BOPP/LDPE.
3. **Coffee chicory powder -** Suitably lined containers, Flexible laminated pouches of paper/LDPE, Foil/LDPE, PET/LDPE.
4. **Coffee powder -** LDPE, HDPE, PP,NC, PVDC Coatings, PS, HDPE, PVC,ABS,

3.4.1 Role of packaging material in coffee powder packaging

Vacuum packs

A common packaging solution for ground coffee is to pack it under vacuum. The absence of any air helps delay most reactions and it keeps all the flavours within.

Metal cans

Another common option is to find ground coffee stored in metal cans. These provide some sturdiness and again aren't very well penetrable for any gases.

Pressurized packaging

After the coffee beans are baked, they are quickly vacuum-packed and then filled with an inert gas seal. This type of packaging ensures that the coffee beans are not oxidized while ensuring that the aroma is not lost and that there is sufficient strength to ensure that the **coffee packaging** is not damaged by air pressure.

Non-hermetic packaging

It is actually a temporary package that is only used for short-term storage.

Paper bags

The paper bags form an excellent packaging material for coffee powder. They may be kraft paper, plastic coated paper, paper boards, solid fibre boards, liner boards, box boards etc.The

papers are used in the form of boxes, bags, wrappers, cartons, cups etc. The advantage of using paper is that it is weightless, capability for printing on the surface, low cost and easy disposability. The disadvantages include low wet and tear strength.

Glass

The glass may be transparent or opaque. Glass is used in the form of bottles and jars.The advantages cited for glass as a packaging material include its strength, rigidity, ability to have a barrier for water and gas and inertness to chemical substances. The disadvantage is its heavy weight, and fragility.

Low polymers

They include cellophane (coated with plain or nitrocellulose / saran / polyethylene), treated with cellulose etc.

High polymers

Polyethylene and polypropylene is commonly used for coffee powder packaging.The merits are they can be easily applied and the packaging process can be readily mechanized.The demerits are: Removal of all air before packaging may lead to spoilage; the most careful attention to detail is necessary, else faulty production will result.

Laminates

They are formed by combining the complete surfaces of 2 or more webs of different films with the primary object of overcoming the defects of single films.Usually laminations are made to strengthen the film material, to improve barrier properties, to improve grease resistance, to provide a surface that will heat seal, etc. Some of the typical laminates available for packaging are paper-polythene, cellophane-polythene, aluminium foil-polythene, paper aluminium foil-polythene, polyester-polythene, etc.

Aluminium foil

The common thickness of the foil used is 0.012 – 0.015 mm. To increase corrosion resistance, it may be lacquered (coated with lacquer) or a thin film of plastic can be applied for packing coffee powder.The advantages of these containers are good barrier properties, grease proof, non-absorption, shrink proof, odourless, tasteless, hygienic, non-toxic, opaque to light, bright in appearance etc. The demerits are its low tear strength, susceptibility to strong acids and alkalis. It is mostly used in the form of wrapper, carton and box.

3.5 ALUMINIUM FOIL PACKAGING STYLES USED FOR COFFEE POWDER

1) Quad Seal and Center Fin Style
2) Doypack
3) Flat bottom flexible bag box
4) Pillow pag
5) Bag in Bag

1) **QUAD SEAL BAG**
A quad seal bag is also very popular in the coffee industry. This bag has crisp side seals, can stand unassisted, and is attention-grabbing for its modular look. This coffee packaging bag type holds its shape very well and can support heavier fills of coffee. The quad seal bag usually is more costly than other bag styles.

2) **DOYPACK**
With a flat top and a rounded, oval-shaped bottom, the doypack or stand-up pouch differentiates itself from more typical coffee package types. It gives the consumer an impression of a premium, small-batch product. Often fitted with zippers, this coffee packaging bag type is beloved by consumers for its convenience. This bag style usually costs more than other more simple bag types.

3) **FLAT BOTTOM BAG**
The flat bottom coffee bag is one of the most popular packaging formats in the coffee industry. It features a prominent shelf presence and is able to stand unassisted for maximum impact. Often the top of the bag is folded over or completely down into a brick shape and sealed.

4) **PILLOW BAG**
The most economical and simplistic bag type.The pillow bag is often used for fractional, single-serve coffee packaging formats.This bag style lays flat for display purposes.

5) **BAG-IN-BAG (BIB)**

Fractional packs of coffee can be packaged bag in bag into a larger package for foodservice or bulk sale purposes. Modern coffee packaging machines can form, fill, and seal the smaller frac packs and subsequently package those into a larger outer wrap on a single bag-in-bag.

Storage conditions for coffee powder after packaging

Coffee powder has to be stored in low temperature, low humidity and pest-free area to prevent agglomeration and flavour loss.

Form fill sealing machine used for coffee powder packaging

Labelling requirements

1. Name of the food
2. List of ingredients
3. Nutritional information
4. Declaration regarding vegetarian or non vegetarian
5. Declaration regarding food additives
6. Name and address of the manufacturer
7. Net quantity
8. Code No/Lot No/Batch No
9. Date of manufacture and Best before or Use by date
10. Country of origin for imported food
11. Instructions for use.

CHAPTER 4

FSSAI STANDARDS AND FOOD SAFETY

4.1 FSSAI STANDARDS AND ADDITIVES OF COFFEE POWDER

2.10.2: COFFEE

1. **Coffee (green raw or unroasted)** means the dried seeds of Coffea arabica,Coffea liberica, Coffee excelsa or Coffea canephora (robusta) with their husks (mesocarp and endocarp) removed.

1.1 Roasted coffee means properly cleaned green coffee which has been roasted to a brown colour and has developed its characteristic aroma.

1.2 Ground coffee means the powdered products obtained from 'roasted coffee' only and shall be free from husk.

1.3 Coffee (green raw or unroasted), 'roasted and ground coffee' shall be free from any artificial colouring, flavouring, facing extraneous matter or glazing substance and shall be in sound, dry and fresh condition, free from rancid or obnoxious flavour.

1.4. Roasted coffee and ground coffee shall conform to the following analytical standards:-

1. Moisture (on dry basis) m/m Not more than 5.0 percent
2. Total Ash (on dry basis) m/m 3.0 to 6.0 percent
3. Acid insoluble ash (on dry basis) m/m Not more than 0.1 percent
4. Water soluble ash (on dry basis) m/m Not less than 65 percent of total ash
5. Alkainity of soluble ash in milliliters of Not less than 3.5 ml & Not more than 5.0 ml 0.1N hydrochloric acid per gram of material (on dry basis) m/m
6. Aqueous extracts on dry basis m/m Not less than 26.0 and not more than 35.0 percent
7. Caffeine (anhydrous)(on dry basis) m/m Not less than 1.0 percent
8. **61[1A. Decaffeinated roasted and ground coffee**

1A.1 Decaffeinated Coffee means, the dried seeds of Coffea arabica, Coffea liberica, Coffea excelsa or Coffea canephora (Robusta) or with their husks (mesocarp and endocarp) removed and decaffeinated to remove nearly all the caffeine from the beans. Decaffeination is carried out while the beans are in green form, before they are roasted.

1A.2 Roasted decaffeinated coffee means properly cleaned green coffee which has been decaffeinated, roasted to a brown colour and has developed its characteristic aroma.

1A.3 Ground decaffeinated coffee means the powdered products obtained from 'roasted decaffeinated coffee' only and shall be free from husk.

1A.4 It shall be free from artificial colouring, flavouring, facing, extraneous matter or glazing substances and shall be in dry and fresh condition, free from rancid or obnoxious flavours. It shall conform to the following standards on dry weight basis, namely: -

(i) Moisture, percent by mass, max 5.0

(ii) Total Ash, percent by mass 3.0 to 6.0

(iii) Acid insoluble ash, percent by mass, max 0.1

(iv) Water soluble ash, percent by mass, min 65.0

(v) Alkalinity of soluble ash in ml of 0.1 N 3.5 to 5.0 hydrochloric acid per gram of material, percent by mass, ml

(vi) Aqueous extracts, percent by mass 26.0 to 35.0

(vii) Caffeine (anhydrous) percent by mass, max 0.1]

2.10.2: COFFEE

2. Soluble Coffee Powder means coffee powder, obtained from freshly roasted and ground pure coffee beans. The product shall be in the form of a free flowing powder or shall be in the agglomerated form (granules) having colour, taste and flavour characteristic of coffee. It shall be free from impurities and shall not contain chicory or any other added substances.

It shall conform to the following standards:

i. Moisture (on dry basis) m/m Not more than 4.0 percent

ii. Total ash (on dry basis) m/m Not more than 12.0 percent

iii. Caffeined content (on dry basis) m/m Not less than 2.8 percent

iv. Solubility in boiling water Dissolves readily in 30 seconds with moderate stirring

v. Solubilty in cold water at 16±2◦C Soluble with moderate stirring in 3 minutes

(ii) 61 [2A. Decaffeinated Soluble Coffee Powder

2A.1 Decaffeinated soluble coffee powder means coffee powder obtained from freshly roasted and ground pure coffee beans from which most of the caffeine has been removed. The product shall be in the form of a free flowing powder or shall be in the agglomerated form (granules)

having colour, taste and flavour characteristic of coffee. It shall be free from impurities and shall not contain chicory or any other added substances.

2A.2 Decaffeinated Soluble Coffee powder or granules shall conform to the following standards on dry weight basis, namely: -

i. Moisture, percent by mass, Max 4.0

ii. Total Ash percent by mass, Max 12.0

iii. Caffeine (Anhydrous,) percent by mass, Max 0. 3

iv. Solubility in boiling water Dissolves in 30 seconds with moderate stirring

v. Solubility in cold water at 16+/- 2˚C Dissolve in 3 minutes with moderate stirring]

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

Director

Indian Institute of Food Processing Technology

(Ministry of Food Processing Industries, Government of India)

Pudukkottai Road, Thanjavur - 613 005, Tamil Nadu

Phone No.: +91- 4362 - 228155, Fax No.:+91 - 4362 - 227971

Email: director@iifpt.edu.in; Web: www.iifpt.edu.in