MINISTRY OF FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA

PM Formalisation of
Micro Food Processing Enterprises Scheme

Processing of Orange RTS

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Beverages are an integral part of human diet, starting from new born. The cycle starts with the infant formulas highly complex drink, rich in many key nutrients. As human age and their nutritional requirements change, product designer keeps pace by developing new and innovative beverages to meet these needs.

1.2 Present Status of National and Global Beverage Market

In India, traditional cuisine includes drinks, which were primarily developed to provide aesthetic appeal, but they also contained certain components having nutritional and therapeutic values as well. However, with course of time these traditional health drinks diminished. According to an estimate Indian consumers drink 120 billion litre of marketed beverages out of which only 4 percent is ready-to-drink packaged once. The current value of Indian beverage industry is around 1,049 million US$. In fact the soft drinks form the third-largest packaged food sector after packaged tea and packaged biscuits. However, the penetration of soft drinks in Indian market is still low. For a long period the Indian beverage industry was dominated by aerated synthetic drinks. However, the situation has changed dramatically, the aerated soft drinks, which had registered a whopping 20% growth during late 90's, could manage its present share in market against possible slide. In contrary to this last few years have witnessed a significant development in fruit based beverages newly introduced fruit beverages fall into the category of functional foods or nutraceuticals. Fruit beverages have gained popularity in recent years. The market size for the bottled water in India had an estimated value of US$ 570 million in 2008. With annual growth rate of 14.5 percent, the market of bottled water is expected to increase rapidly in coming years.

Future of Indian beverage market is quite promising and sectors that may attract processors and consumers alike include the functional dairy drinks, fruit beverages and wine. Advancement in processing and packaging technology in the form of UHT/Aseptic processes and tetrapak packaging offers newer opportunity to deliver nutritious beverages in log-life version.

1.3 Fruit Beverages

Fruit beverages and drinks are one of the popular categories of beverages that are consumed across the globe. The fruit beverages and drinks are easily digestible, highly refreshing, thirst quenching, appetizing and nutritionally far superior to most of the synthetic and aerated drinks. In recent past the consumption of fruit based beverages and drinks has increased at a fast rate. Fruit RTSs or pulp used for the preparation of these products are subjected to minimal processing operations like filtration, clarification and pasteurization. The fruit RTS or pulp, are mixed with ingredients like sugar, acid, stabilizers, micronutrients and preservative to develop beverages and drinks. The principle groups of fruit beverages are as follows:

- Ready-to-Serve (RTS) pre-packaged Beverages
- Fruit RTS and Nectars
- Dilutable beverages

1.3.1 Health Importance of Beverages

Beverages are essential for growth, development as well for carrying out various physiological processes that are critical for living a healthy life. In adult individuals 70 percent of body weight, 73 percent of lean muscle, 25 percent of adipose tissues, 22 percent of bone and 80 percent of blood consists of water. Consumption of beverages help in maintaining the water content in body and prevent dehydration.

The water assists in digestion, assimilation and excretion of foods. It also helps in removing the toxic substances produced in body as a result of metabolisms such as urea, uric acid, ammonia etc. through kidney. Water in beverages help in regulating the temperature of body through the process of sweating. Beverages specially the fruit and vegetable based ones are source of micronutrients (vitamins and minerals) and anti-oxidants (carotenoids, flavonoids).

1.3.2 Ready-to-Serve (RTS) Beverages

The ready-to-serve beverages as per FSSAI specifications should contain at least 10% fruit content and not less than 10 % TSS besides 0.3% acid maximum as citric acid. The levels of permitted preservatives include 70 ppm (maximum) for sulphur dioxide and 120 ppm (maximum) for benzoic acid. The total plate count and yeast and mold counts should not exceed, to 50.0 cfu/ml and 2.0 cfu/ml, respectively. The Coliform counts should be nil in 100 ml beverage samples.

Since these beverages are consumed as such without dilution, hence are termed as Ready-to-servebeverage. The majority of packaged fruit beverages belong to this category.

Wide range of fruits including mango, citrus fruits, berries, litchi, guava, pineapple, grapes etc. are preferred for RTS beverages. Required amount of sugar, acid, stabilizer, colouring and flavouring ingredients are added in RTS or pulp along with water and the mixture is blending properly, filtered if desired. The RTS mix is pasteurized (80-90°C) in bottle (20-30 min), continuous RTS pasteurizer (few seconds to one minute) and cooled immediately. Nowadays, UHT processing of RTS beverages is quite popular because of longer shelf-life and less loss of nutrients during processing.

The amount of fruit RTS or pulp may vary according to fruit and cost effectiveness. The presence of oxygen in headspace often leads to oxidation resulting in off-flavour and loss of nutritive value, hence anti-oxidants such as ascorbic acid is often added in RTS beverages. Besides it, colour and flavour ingredients which are stable to heat and oxygen are preferred.

CHAPTER 2

PREPARATION OF ORANGE

2.1 Orange

Sweet orange (*Citrus sine nsis* L.) is one of the most important subtropical fruits of India and belongs to the family Rutaceae. It is widely consumed fruit RTS by normal as well as sick people and is well known for its instant energy, pectins, vitamin C and potassium content. Sweet orange RTS is refreshing after any hectic activity or on a dry, hot day to quench thirst.

The post-harvest losses of citrus fruits are 5-10% in most developed countries and 25-30% in developing countries. Orange fruits are processed into value added products like Ready to Serve beverages to fetch continuous income to the farmers.

Nutritional composition of orange fruit per 100ml	
Energy (Kcal)	42
Total sugars (g)	9
Vitamin – C (mg)	45
Potassium (mg)	176
Folate (mcg)	215
Total carbohydrates (mg)	0.7
Hesperidin (mg)	52
Pectins (mg)	33.4

2.1.1 Health benefits of orange RTS

- Regulate blood pressure
- Prevent cancer
- Helps in blood circulation
- Balance cholesterol
- Helps for glowing skin
- Helps in weight loss

2.2 Orange RTS processing

RTS and RTS products represent a very important segment of the total processed fruit industry. RTS products are being marketed as refrigerated, shelf-stable, and frozen, in a variety of packages with increased emphasis on functionality, health attributes, new flavours or blends, and in some cases fortified with vitamins and minerals. High-quality RTS operations are dependent upon a source of high-quality raw material. Most fruit RTSs are excellent sources of vitamin C, several are good sources of carotene and many contain moderate amounts of pyridoxine, inositol, folic acid and biotin. Fruit RTS is regarded as source of energy due to their rich carbohydrate content. The organic acids present in the fruit RTS plays a significant role in the maintenance of the acid-base balance in the body.

The process starts with sound fruit, freshly harvested from the field or taken from refrigerated or frozen storage. Thorough washing is usually necessary to remove dirt and foreign objects and may be followed by a sanitation step to decrease the load of contaminants. Sorting to remove decayed and mold contaminated fruit is necessary to make sure that the final RTS will not have a high microbial load, undesirable flavours, or mycotoxin contamination. For most fruits, preparation steps such as pitting and grinding is required prior to RTS extraction. Heating and addition of enzymes might also be included before the mash is transferred to the extraction stage. RTS extraction can be performed by pressing or by enzymatic treatment followed by decanting. The extracted RTS will then be treated according to the characteristics of the final product.

For cloudy RTSs, further clarification might not be necessary or may involve a coarse filtration or a controlled centrifugation to remove large insoluble particles. For clear RTSs, complete de-pectinization by addition of enzymes, fine filtration, or high speed centrifugation is required to achieve visual clarity. The next step is usually a heat treatment or equivalent non-thermal process to achieve a safe and stable RTS and final packaging if single-strength RTS is being produced.

For a concentrate, the RTS is fed to an evaporator to remove water until the desired concentration level is obtained. Other processes used for water removal include reverse osmosis and freeze concentration, which are best suited for heat-sensitive RTSs. The concentrate is then ready for final processing, packaging, and storage.

2.3 Flow chart for preparation of Orange RTS

Fruits

↓

Washing

↓

RTS extraction

Mix sugar + Citric acid + water

(Dissolve sugar completely)

↓

Cooling

Filter through muslin cloth

↓

Pasteurisation (80°C for 10min)

↓

Addition of KMS (@750ppm + 500ppm)

↓

Cool at room temperature

↓

Packing and Storage

2.3.1 Unit operation involved in processing of RTS beverages

Orange RTS is a complex product. A good understanding of the basic nature and properties of orange RTS is therefore needed for processing and packaging orange RTS.In fact, such knowledge is indispensable for ensuring that high product quality is maintained during RTS processing. The quality of orange fruit is important for the characteristics of the final orange RTS product. Oranges are natural products and therefore vary significantly in flavour, vitamin C content and colour according to the variety of orange, the time of season when harvested and the region of the world where they are grown.

2.3.2 Sorting & washing

A prerequisite for initial high RTS quality is the use of whole, undamaged oranges with low microbial populations. Then they are washed with the help of chlorinated water. Then they are moved on to the washing tank by an elevator.

2.3.3 Fruit preparation

The aim of this step is to smash, cut the fruit, increase its surface, and launch cell-fluid elimination. However, this can lead to enzymatic reactions damaging valuable components. Therefore, the fruit has to be processed immediately after it is cut opened.

2.3.4 Methods of extraction

There are different methods of separation available includes: pressing, diffusion, centrifugal procedures, and reverse-osmosis. The type of equipment applied depends on the fruit species, production line, and economical background. The most widely used solution is pressing. Pressing separates a food system into two phases. In this case, fruit tissues mean the solid phase, while the liquid between the particles is the liquid phase. Pressing needs outside forces to create tension in the system, drain liquid, resulting in shape modification.

The equipment hinders the disposal of the solid phase and the liquid gathers in a vessel. The remaining material, with low liquid content, is called marc. The most important parameter of pressing is the liquid yield, which means the percentage of RTS extracted, compared to the raw material at the beginning of the process. RTS yield is basically determined by the type of the pressing device, and the quality and preparation of the raw material.

In recent years there has been considerable interest in using extraction instead of expression for recovering RTSs from fruits and vegetables. Countercurrent screw extractors, some operated intermittently, have been used to extract RTS with water. In some cases this results in higher yields of good quality compared to that obtained by expression.

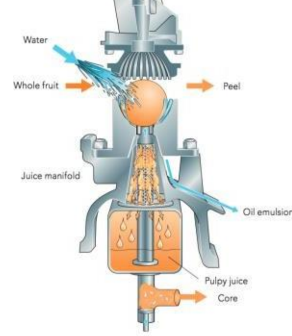
Centrifugation may be used for a variety of tasks in fruit RTS processing. Self-opening centrifuges are used to remove pulp and control the level of pulp remaining in citrus RTSs. The use of hermetically sealed centrifuges prevents excessive aeration of the RTS.

2.3.5 Energy optimising

Proper RTS extraction is important to optimize the efficiency of the RTS production process as well as the quality of the finished drink. The latter is true because oranges have thick peels, which contain bitter resins that must be carefully separated to avoid tainting the sweeter RTS. There are two automated extraction methods commonly used by the industry.

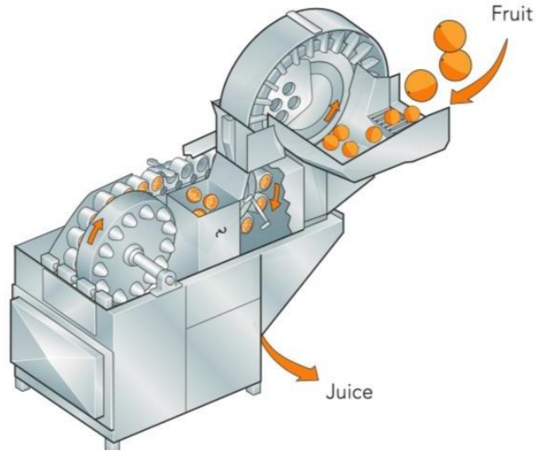
2.3.6 Method 1:

In the first place the fruit between two metal cups with sharpened metal tubes at their base. The upper cup descends and the fingers on each cup mesh to express the RTS as the tubes cut holes in the top and bottom of the fruit. The fruit solids are compressed into the bottom tube between the two plugs of peel while the RTS is forced out through perforations in the tube wall. At the same time, a water spray washes away the oil from the peel. This oil is reclaimed for later use.



2.3.7 Method 2:

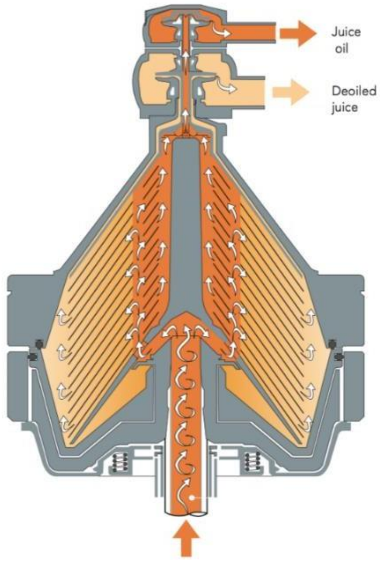
The second type of extraction has the oranges cut in half before the RTS is removed. The fruits are sliced as they pass by a stationary knife and the halves are then picked up by rubber suction cups and moved against plastic serrated reamers. The rotating reamers express the RTS as the orange halves travel around the conveyor line. Some of the peel oil may be removed prior to extraction by needles which prick the skin, thereby releasing /the oil which is washed away. Modern extraction equipment of this type can slice, ream, and eject a peel in about 3 seconds.



Orange RTS extraction (Reamer type)

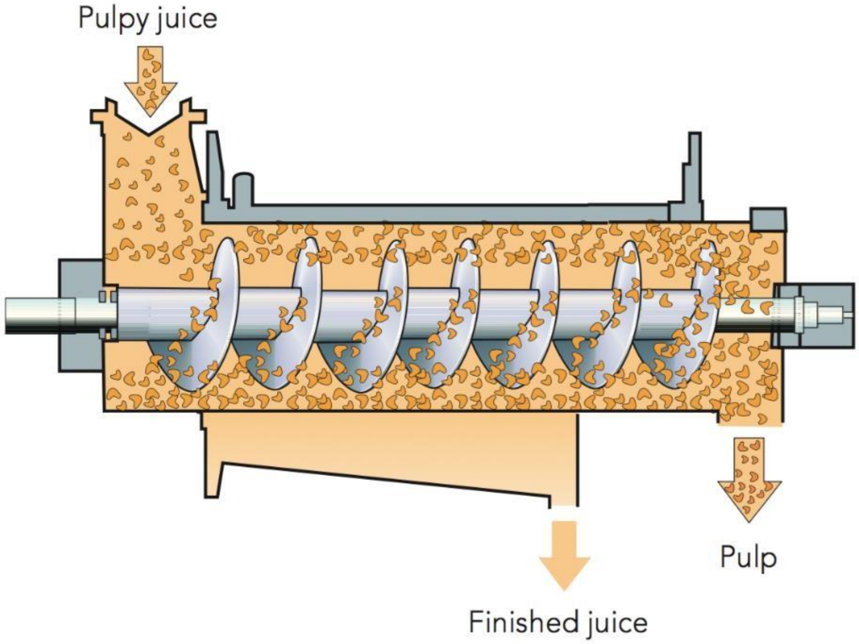
2.3.8 Straining/Filtration/Clarification

The RTS leaving the extraction unit contains too much pulp and membrane material. Clarification is done to separate RTS by removing pulp. Extracted fruit RTS contains varying amount of suspended solids – broken fruit tissue, seed, skin & various gums, pectic substances and proteins in colloidal suspension. Coarse particles removed by straining (non-corrodible metallic screens) or sedimentation. If clear RTS required, complete removal of all suspensions effected through filtration or clarification with the help of fining agents.

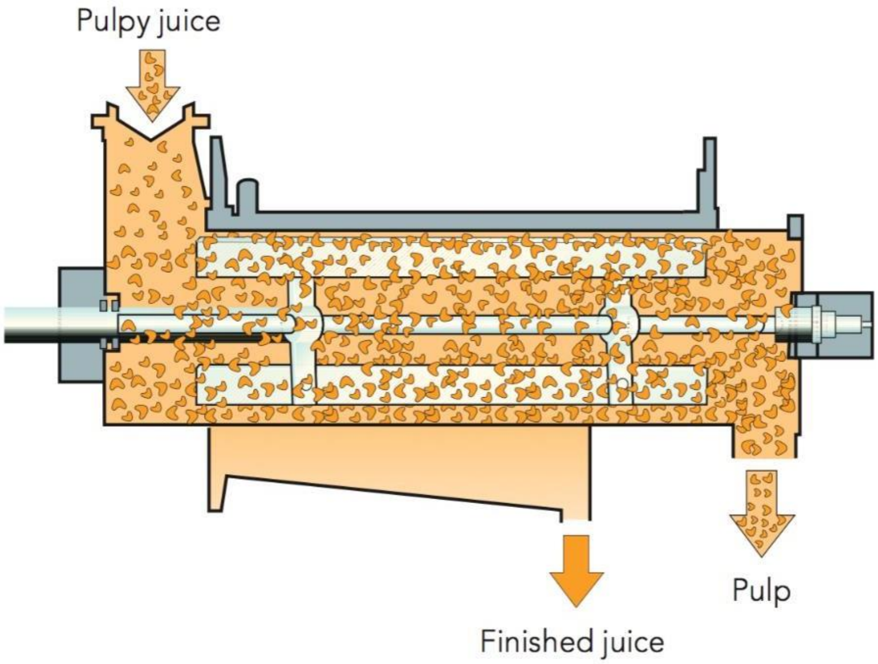


2.3.9 Orange Decanter

To reach crystal clear the solid particles in suspension causing turbidity and colloidal particles are removed with the aid of filter. By adding aromas and regulatory becomes ready for sale. The pulp stream, containing pieces of ruptured RTS sacs and segment walls, may then go to pulp recovery or to pulp washing.Centrifugation of orange RTS is done to remove to separate the suspended solids. Centrifugation is done at 12000rpm for clarification.



Screw type clarifier



Paddle type clarifier

2.3.10 Pasteurisation (Preheating)

Pasteurisation deactivates the enzymes present in the RTS and makes the RTS microbiologically stable. It is carried out using tubular or plate heat exchangers. The choice of heat exchanger depends on the amount and type of pulp in the product. Tubular heat exchangers are best choice for RTS containing floating pulp. RTS beverages is more sensitive to microbial contamination and also dissolved oxygen causes vitamin-c deterioration during storage. Hence pasteurisation is major concern in RTS processing to enhance the shelf life of RTS beverage.In pasteurisation tank orange RTS is preheated at 74°C and then pasteurised to kill bacteria. Two main aim of pasteurisation of RTS beverages are

1) To deactivate enzymes
2) To make the RTS microbiologically safe.

PLATE HEAT EXCHANGER

2.3.11 Deaeration

Deaeration refers to the removal of oxygen from RTS beverage. The presence of oxygen in RTS can promote enzymatic browning, destroy nutrients, modify flavours and damages quality. Orange RTSs from the press is blurred. According to the density difference, artificial centrifugal force separation process is provided. Solid particles (sediment) from fruit RTS is separated.Orange RTS which is extremely susceptible to the adverse action of the residual air, is subjected, immediately after extraction, to a high vacuum whereby most of the air as well as other gases are removed.

2.3.12 Debittering

Limonin is the main bitter fraction of "Navel" oranges. The non bitter mono-lactone of limonic acid gets rapidly converted to bitter tasting dilactone i.e. limonin at pH of about 3.0. Delayed bitterness is due to chemical change i.e. conversion of nonbitter precursor to bitter compounds by the process of extraction of the RTS. In debittering unit, the bitterness of the RTS is removed with the help of resin. Use of pectic enzymes (resin) remove the dispersed colloids by coagulation and subsequent precipitation, they carry the bitter principles with them.

2.3.13 Sterilisation

Sterilization of the RTSRTS by In-can (retort) or by Ultra high treatment (UHT) followed by aseptic packaging can help in extending the shelf life for months even under ambient storage conditions. In this section the RTS is sterilised and the microorganisms are fully destroyed.

Four section of sterilisation process are:

1) Heating by steam at 103°C
2) Holding (3min)
3) Cooling (by normal water)
4) Chilling (5°)

2.3.14 Aseptic filling and storage

In this section HDPE pouches and bags are sterilised by steam and RTS in filled in pouches. Then the RTS is stored at 3-6°C temperature.

2.4 Impact of processing on orange RTS

Processing steps to stabilize extracted orange RTS with respect to enzyme and microbial activity are indispensable before concentration, bulk storage, packaging and distribution. Heat treatment with respect to time/temperature settings should be designed to minimize unwanted chemical and flavour changes in the product. Loss of quality during processing is largely similar to that encountered during packaging and shelf storage.

1) **Oxygen impact on vitamin-C degradation**
2) **Thermal impact on vitamin-C degradation**
3) **Flavour changes**

1) Oxygen impact on vitamin-C degradation

During orange RTS reconstitution and further processing steps, oxygen has an important impact on RTS quality. Oxygen is a very reactive element that can induce several changes in the chemical composition of orange RTS, the most significant of which is the loss of vitamin C and consequent loss of nutritional value.

It is generally agreed that vitamin C degradation in citrus RTSs can occur through both aerobic (depending on oxygen) and anaerobic (not depending on oxygen) reactions of a non-enzymatic nature. Which of these predominates depends on the temperature and availability of oxygen. During processing, the aerobic degradation of vitamin C predominates.

2) Thermal impact on vitamin-c degradation

Vitamin C degradation occurs faster as temperature increases, as with many chemical reactions. One might therefore conclude that pasteurization would result in large vitamin C losses. However, the time that the RTS is at pasteurization temperature is very short (15-30 seconds). Measurements of vitamin C content in different beverages before and after pasteurization show that vitamin C losses are actually very small.

3) Flavour changes

The desirable taste of freshly squeezed orange RTS is easily affected by heat treatment and subsequent bulk storage.The RTS may undergo several chemical reactions that can degrade the original volatile flavours of the RTS. In addition, off-flavours can be formed mainly from compounds in the aqueous RTS matrix. The Maillard reaction, a well-known reaction between sugars (or vitamin C) and amino acids, is an example of flavour changes.

Several potential off-flavour molecules have been identified in orange RTS. Most of these compounds are formed during RTS storage, though it takes a long time (several months) or storage at high temperature before any off-taste is noted – that is to say, when the compounds responsible for an off-taste are present in high enough concentration. One exception is 4-vinyl guaiacol (PVG). This compound has been found in concentrations above its perception threshold in newly extracted and processed RTS. It imparts an old fruit or rotten fruit aroma to the RTS.PVG forms from ferulic acid, an odourless compound normally present in RTS. The concentration of free ferulic acid in RTS has been shown to double after the first pasteurization step, thereby greatly increasing the possibility of PVG forming.

Concentrating orange RTS in an evaporator removes the volatile water-soluble and oil-soluble components that provide most of the characteristic orange flavour. The process flavour (also known as “pumpout flavour”) obtained is a combination of the loss of volatile flavour and the cooked taste resulting from heat treatment. These undesired changes can be compensated for by addition of flavour fractions at a later processing stage.

2.5 ROLE OF INGREDIENTS USED FOR PREPARATION OF RTS BEVERAGES

2.5.1 Sugar

Sugars are added primarily as flavouring additive to impart the sweetness in the beverages. Conventionally sugar performs number of basic functions in beverages.

- They improve the palatability of certain bland and insipid tasting fruits & vegetables
- They provide bulk and body to beverages thus enhance mouthfeel
- They modify the freezing point and control viscosity
- They also act as mild preservative, modify the osmotic pressure and check spoilage

2.5.2 Acidulants

Acidulant are acids that either occur naturally in fruits and vegetables or are used as additives in beverage formulation. Mainly, citric acid, adipic acid, fumaric acid, tartaric acid, phosphoric acid, lactic acid malic acid and acetic acid are used to play different roles in different beverages. Acidulants functions includes

- Provide sourness to product
- Enhance palatability by balancing the sugar to acid ratio
- Enhance flavours
- Act as thirst quenching by increasing flow of saliva
- Act as buffer to control acidity level
- Act as a mild preservative by regulating pH

a) Citric acid

Citric acid is the most versatile and widely used food acidulant. It is useful characteristics include excellent solubility, extremely low toxicity, chelating ability and pleasantly sour taste. FDA classifies citric acid and its sodium and potassium salts as GRAS food additives when used in accordance with the good manufacturing practices. Citric acid is produced commercially by mold fermentation of sugar solutions (most commonly, dextrose and beet molasses) using strains of *Aspergillus niger*. Beverages are the major food use for citric acid, accounting for an estimated 65% of citric acids total food acidulant consumption. Citric acid and its sodium salt are used extensively in carbonated beverages as a buffer to regulate tartness if the acid level is high. It is also used as flavor enhancers and preservative.

b) Malic acid

Malic acid is prepared by hydrolyzing maleic anhydride to malic acid and, at elevated temperature and pressures, forming an equilibrium mixture of malic acid, fumaric acid, and malic acid. Malic acid is used in a variety of products, but mostly in fruit-flavoured sodas such as those with apple and berry flavor. Malic acid is preferred acidulant in low-calorie drinks, and in cider and apple drinks, it enhances flavor and stabilizes the color of carbonated and noncarbonated fruit flavoured drinks and cream sodas. In sugar-free drinks, malic acid masks the off-taste produced by sugar substitutes.

c) Tartaric acid

Tartaric acid has a strong, tart taste and augments natural and synthetic fruit flavours, especially grape and cranberry. It is utilized in fruit RTSs and drinks. High prices and limited availability inhibit tartaric acid from widespread use as a food acidulant.

d) Phosphoric acid

Phosphoric acid and its salts account for 25% of all the acids used in the food industries. Phosphoric acid has a characteristic flavor and tartness and is used almost entirely in cola flavored carbonated beverages. A small quantity is also used in some root beer brands. It is least costly of all the food-grade acidulant; it is also the strongest, giving the lowest attainable pH.

e) Fumaric acid

Fumaric acid is principally used in fruit RTSs and gelatin desserts and wines. Fumaric acid competes with other acidulants such as citric acid, tartaric acid, and malic acid. Although it is less costly than some alternatives, its relatively strong acid taste and low solubility make it less appropriate for certain food uses. Its limited solubility coupled with an extremely low rate of moisture absorption makes fumaric acid a valuable ingredient for extending the shelf life of powdered dry mixes.

There are certain other acidulants like ascorbic acid, adipic acid, acetic and lactic acid that may also be used in beverage formulation mostly in combination with major acids. Ascorbic acid also acts as antioxidant.

2.5.3 Flavourings

Flavors are concentrated preparations used to impart a specific aroma to food or beverages. Flavors may be added to food products for the following reasons:

- To create a totally new taste
- To enhance, extend, round out or increase the potency of flavours already present
- To supplement other more expensive flavors or replace unavailable flavors
- To mask less desirable flavors- to cover harsh or undesirable tastes naturally present in some food
- Stimulation of flavour perception of expensive flavours

Flavouring is most critical operation in food processing as acceptability of any products largely governed by the flavour perception by consumers. Various food processing operations often lead to loss of flavouring chemical either due to volatilization or because of conversion of flavouring compounds into off-flavouring compounds. However, flavour of beverage must be identical to the fruit which is used as base material. Fruit aroma consists of few hundreds to thousand compounds for example orange flavour contain more than 200 compounds ranging from simple phenolic to complex terpenoids, esters etc. Therefore, mimicking of fruit flavour in beverages is quite complex task and requires great expertise. Various compounds used for flavouring purpose may be categorized into three groups.

2.5.4 Colourings

Colours are used in processed foods to improve the appearance and thus also influence the perception of texture and taste. The colours are permitted additives in beverage to provide different shades and improve the aesthetic quality of beverages. Food colours are added in beverages because of the following reasons:-

- To give attractive appearance to foods that would otherwise look unattractive or unappealing
- For product identification as majority of fruit beverages are characterized by the colour of fruit which is used in its formulation
- To ensure uniformity of the colour due to natural variations in colour intensity because of variation in harvesting period, variety etc.
- Intensification of the colour naturally occurring in fruits & vegetables
- Colours also serve as mean of quality assurance during the production, transportation and storage.

2.5.5 Hydrocolloids

These consists a group of substances all of colloidal dimensions, having great affinity for water and hence called as hydrocolloids. These hydrocolloids perform a number of functions in fruit RTSs and beverages:

- Prevent gravitational suspension or sedimentation of suspended particles in beverage
- Improve the viscosity of RTSs and beverage

- Act as clouding agent in products like nectar, lemonades, where cloud formation is a desirable attributes
- Act as clarifying agent in certain beverages like guar gum, alginates, gelatin, They cause flocculation of impurities
- Assist in encapsulation of additives in powdered mixes
- Prevent crystallization in high sugar containing beverages

2.5.6 Pectin

Pectin is a hydrocolloid obtained commercially from the citrus peel or apple pomace. It consists of α-galacturonic acid molecules which are linked through α-glycosidic linkages and the side chain of pectin molecule is esterified. Pectin is mainly used for gelling purpose but nowadays it is gaining popularity as beverage stabilizers. Major application of pectin (High methoxyl) is in stabilization of acidified dairy drinks. Besides it the major application of pectin is in preparation of gelled products such as jam, jelly and marmalade.

2.5.7 Preservatives

A chemical preservative may be defined as any additive substance that tends to prevent or retard deterioration when added to foods. It may prevent or retard changes in odour, flavor, nutritive value, or appearance. They inhibit the contamination of foods by microorganisms such as yeasts, bacteria, molds or fungi. The principal mechanisms are reduced water availability and increased acidity. Only sorbates, benzoates, propionates and sulfites are used broadly in fruit processing. The principal mechanisms are reduced water availability, change in redox-potential and increased acidity. Many of these preservatives target microbial membranes and affect the permeability of it, thus the viability of microbe. Preservatives may be classified as Class I & Class II preservatives. Class I preservative includes additives from natural sources which also exhibit preservative effects in foods. Example of Class I preservatives are salt, sugar, vinegar, spices, honey, edible oils etc. Class II preservatives are chemically derived compounds. Only sorbates, benzoates, propionates and sulfites are used broadly in fruit processing. In case of Class I preservatives level of addition is regulated by Good

Manufacturing Practices (GMP), while in Class II preservatives it is fixed by regulatory agencies on the basis of safety and toxicity evaluation.

a) Benzoic acid

Benzoic acid and sodium benzoate is permitted to the maximum level of 0.1%. Benzoic acid and its sodium salt are most suitable for preserving foods and beverages that naturally are in a pH range 2.5 - 4.0. The narrow pH of its activity limits wider application of this preservative in foods. Benzoic acid and sodium benzoate are used to preserve carbonated @ 0.03-0.05% and non-carbonated beverages @ 0.1%, fruit pulps and RTSs, jams and jellies, salad dressings, sauces and ketchups. Sodium benzoate is more effective against yeasts and bacteria than molds. The antimicrobial activity varies with foods, its pH and water activity and with types and species of microorganisms. Pathogenic bacteria may be inhibited by concentrations of 0.01-0.02% undissociated benzoic acid. As an antimicrobial agent, benzoate acts synergistically with sodium chloride, sucrose, heat, carbon dioxide, and sulphur dioxide.

b) Sorbic acid

Sorbic acid is widely used food preservatives in the world. Sorbates exhibit inhibitory activity against a wide spectrum of yeasts, molds and bacteria including most food borne pathogens. They can be used to suppress yeasts during lactic fermentation. The inhibitory activity of sorbates is attributed to the undissociated acid molecule and hence is pH dependent. The upper limit for its activity is at about pH 6.5 in most applications, and the activity increases with decreasing pH. Potassium sorbate is used where high solubility is desired. Sorbates are frequently used in dried fruits, fruit salads, carbonated and noncarbonated beverages. Usage rates of sorbates in fruits are low, being 0.025-0.075% in fruit drinks and 0.1% in beverage syrups.

c) Salts of sulphite, bisulphite and metabisulphite

Salts of sulphite, bisulphite and metabisulphite is decomposed by weak acids such as citric, tartaric, malic and carbolic acids to form potassium salt and sulphur dioxide, which is liberated from potassium sulphurous acid with water, when added to the frit RTS or squash. Free sulphurous acid is more effective (120 times) than combined sulphurous acid. The undissociated sulphurous acid molecule prevents the multiplication of yeasts, while the sulphurous acid ion inhibits the growth of bacteria. Glucose, aldehydes, ketones, pectin and breakdown products of pectin, etc., which are found in fruit RTSs, combines with sulphur dioxide reducing the effectiveness of sulphur dioxide. Being more effective against molds than yeasts, sulphur dioxide has found wide use in the fermentation industries. It cannot be used in the case of some of the naturally coloured RTSs like *phalsa, jamun,* pomegranate, strawberry pulp, etc. on account of its bleaching action on anthocyanin. It cannot also be used in products, which are to be packed in tin container, because it not only acts on tin container causing pinholes, but also forms hydrogen sulphide, which has an unpleasant smell and also forms a black compound with the iron on the base plate of the tin container.

d) Nutritive additives

Vitamins

Beverages are enriched with vitamins to adjust for processing losses or to increase the nutritive value. Such enrichment is essential for fruit RTSs canned vegetables, and other beverages. Vitamin C (ascorbic acid) is the most commercially important vitamin used as a food additive in terms of volume. The most important applications for vitamin C include fruit RTSs, fruit flavoured drinks, RTS-added sodas, and dry cocktail or beverages powder mixes. As an antioxidant, this vitamin is frequently added to fruit RTS to preserve and protect against color change of fruit ingredients.

Minerals

Beverages are usually an abundant source of minerals as they contain fruits, but due to dilution the relative intake of minerals is quite less. Normally the electrolytes i.e. sodium, potassium and chlorides are added in energy drinks and other soft drinks. Nowadays, beverages are also considered an important vehicle for mineral fortification. The minerals normally used for fortification are calcium, iron, zinc and magnesium.

2.5.8 Quality checking during storage

- TSS
- Titratable acidity
- pH
- Vitamin - C content
- Colour
- Microbial counts

IIFPT PILOT PLANT FRUIT BEVERAGE PROCESSING UNIT

CHAPTER 3

PACKAGING OF ORANGE RTS

One of the primary aims of a packaging system is to protect the product from microbial spoilage and chemical deterioration during distribution and storage. For orange RTS, measures should be taken to protect vitamin C and flavour compounds, and to prevent microbial growth and colour changes. Vitamin C is the compound in orange RTS that reacts most readily with oxygen, and its loss correlates with the oxygen-barrier properties of the package. The degradation products of vitamin C contribute to browning. Light, in combination with excessive oxygen (head-space and dissolved oxygen, and high oxygen permeation through the package), is known to accelerate flavour changes and aerobic degradation of vitamin C. Anaerobic degradation of vitamin C also takes place but independent of oxygen.

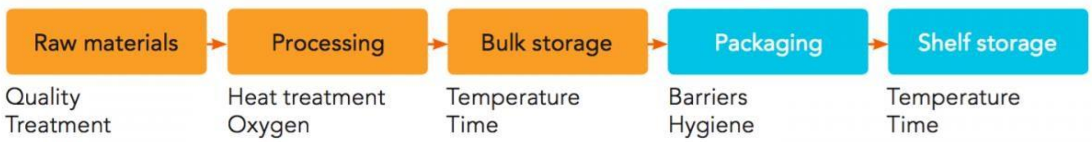
3.1 Quality factors that affects orange RTS

- ✓ High storage temperatures combined with oxygen are the main factors involved in quality deterioration over time.
- ✓ The results are loss of nutritional value concerning vitamin C, unpleasant colour changes, and off-flavour formation, which is caused predominantly by chemical changes in the RTS matrix and, to a lesser degree, by changes in the volatile flavour fraction.
- ✓ Almost all changes can occur under anaerobic storage conditions and are greatly accelerated by oxygen (headspace and dissolved oxygen, and oxygen permeating through the package).
- ✓ In general, packaging for orange RTS should contain an aroma barrier to prevent aromas permeating out through the package.

3.1.1 Role of packaging

In addition to its most obvious function of containing the product, a consumer package must protect the specific quality parameters of orange RTS.Therefore these quality parameters should be protected during a given shelf life.

- Protect the relevant flavour compounds
- Protect the high vitamin C content
- Prevent colour changes
- Prevent microbial growth



3.1.2 Factors affecting quality parameters during storage

No packaging system is able to completely prevent changes in quality taking place in orange RTS – or other beverages in general – during storage. From the day of processing to the day of consumption, the product will change to a certain extent dependent on storage conditions. And in most cases, with the possible exception of wines, the changes will be for the worse. With regard to the quality parameters already identified for orange RTS, the packaging and storage conditions given in Table belowinfluence how long an acceptable quality can be retained during storage.

Package properties	**Storage conditions**
Barrier against	• Oxygen
• Time	• Temperature
• Light	• Aseptic
• Flavour losses	• Non-aseptic
• Microorganisms	

3.2 Barrier requirements of packaging of RTS

3.2.1 Barrier properties against oxygen

Oxygen plays a major role in the loss of quality in orange RTS during storage, mainly because of:

- Vitamin C degradation
- Colour changes (browning)

3.2.2 Vitamin C degradation

Vitamin C is the most oxygen-sensitive compound in orange RTS. Its loss is thus closely related to oxygen content in packages. Generally, vitamin C is lost through two different chemical pathways – anaerobic and aerobic degradation. As its name implies, the anaerobic pathway is independent of oxygen and dependent mainly on storage temperature. Losses caused by anaerobic degradation cannot be prevented by packaging and are the same in all types of package. The only possible counter-measure is to reduce storage temperature.

The aerobic pathway needs oxygen and is therefore strictly related to the presence of headspace oxygen and oxygen dissolved in the RTS, as well as the oxygen-barrier properties of the package.Both anaerobic and aerobic degradation take place simultaneously in orange RTS. Which one dominates depends on storage temperature and oxygen availability.For packages with good oxygen-barrier properties, for example glass bottles, anaerobic degradation plays the major role regarding total vitamin C loss. In cases where oxygen permeation into the package is considerable, headspace oxygen is present or oxygen is dissolved in the product, the contribution of anaerobic degradation to total vitamin C loss is small compared to aerobic degradation.

3.2.3 Colour changes

The colour of orange RTS is primarily determined by its carotenoid content. However, carotenoids are relatively stable in orange RTS since they are protected by vitamin C and are not regarded as being responsible for the colour changes that occur during long-term storage at ambient temperature. The colour changes, or rather the darkening, during storage are based on the appearance of brown-coloured compounds caused by the chemical reaction of orange RTS components present in the RTS matrix. The brown compounds are formed in the end phase of the so-called “Maillard Reaction” (also known as non-enzymatic browning), which is a well-known reaction between sugars and amino acids. This reaction type is generally not dependent on oxygen, but is clearly temperature-driven.

3.2.4 Flavour changes

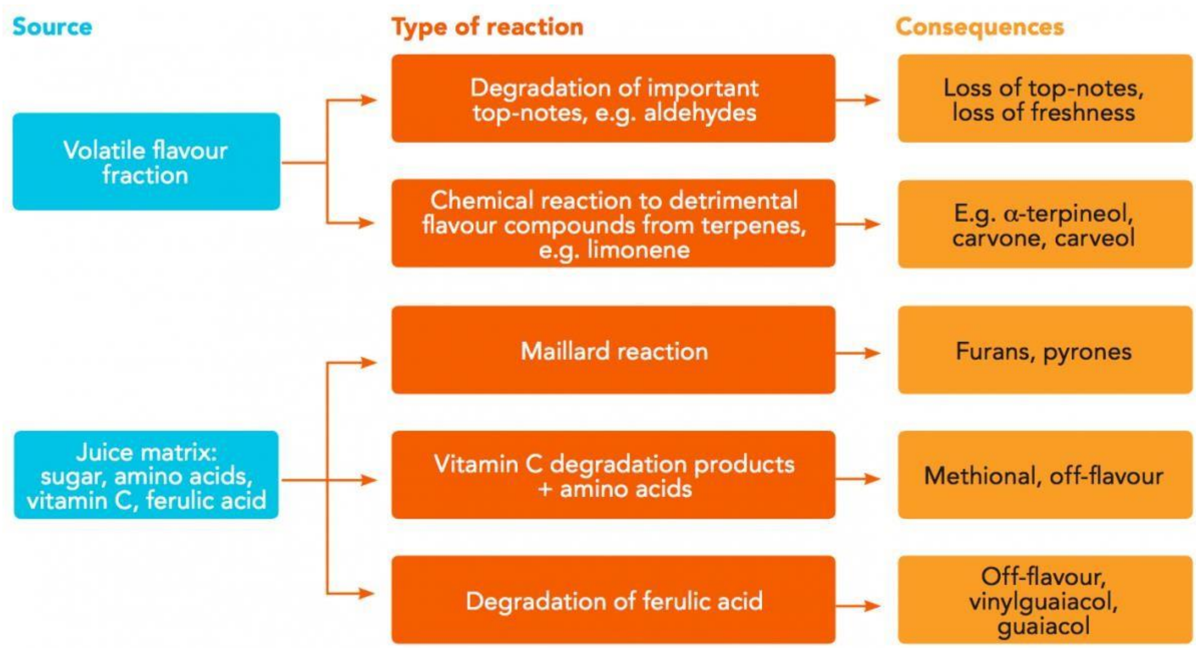
The orange RTS flavour is composed of a broad mixture of different aroma fractions. These aroma compounds may undergo several changes during storage that gradually lead to a loss of freshness and the formation of an unpleasant aroma (off-flavour). Most of these changes are acid-catalyzed reactions, which are supported by the acidity of the RTS and accelerated by high storage temperatures.

Degradation pathways of important aroma fractions like aldehydes include oxidative reactions. Thus, it cannot be excluded that oxygen content and hence the oxygen-barrier properties of the packaging solution have an impact on the aroma of the packed orange RTS. However, as vitamin C is a quantitatively important anti-oxidant in orange RTS and immediately reacts with available oxygen, the impact of oxygen on the aroma is less pronounced as long as vitamin C is present. Three compounds have been identified as important off-flavour contributors in orange RTS, independent of the packaging used. These compounds, which gradually develop in RTS, are:

- 4-vinyl guaiacol (PVG)
- 2,5-dimethyl-4-hydroxy-3(2H)-furanone (DMHF)
- alpha-terpineol

When these compounds are added to freshly prepared orange RTS, PVG imparts an old fruit or rotten fruit aroma; DMHF imparts a pineapple-like aroma typically found in old orange RTS and alpha-terpineol is described as stale, musty or piny.

The formation of PVG results from storage-induced changes in the RTS matrix, DMHF results from the so-called Maillard reactions between carbohydrates and proteins, and á-terpineol is a degradation product of the aroma compound limonene. All three reactions are supported by the acidity of the RTS and storage temperature. Since vitamin C's oxidative degradation products can participate in the Maillard reactions, the package oxygen-barrier properties (and thus a more pronounced vitamin C decay) can to a certain extent also impact the sensory properties of orange RTS, primarily colour (browning) and, to a lesser degree, flavour.



3.2.5 Barrier properties against light

Light is known to accelerate the aerobic (but not an-aerobic) degradation of vitamin C. One can therefore conclude that:

- Light has an effect only when oxygen is present. Consequently, packages with high oxygen-barrier properties, such as glass and high-barrier PET bottles, do not need a light barrier.
- During storage at ambient temperature in packages with a good oxygen barrier, low oxygen permeation rates limit the rate of vitamin C degradation.

Moreover, all oxygen entering through the package is almost immediately consumed. Thus, light cannot accelerate the reaction and therefore has no significant impact.

- During chilled storage, for which packages with higher oxygen permeability are mainly used and the reaction between vitamin C and oxygen is significantly slowed down, oxygen will accumulate in the product. Light can then accelerate vitamin C degradation.

As a result, light protection should be primarily considered for use in packages for chilled distribution that have low oxygen-barrier properties.

3.2.6 Barrier properties against aromas

In most cases, orange RTS packaging is required to provide a barrier that prevents aroma compounds from permeating out through the package. Another requirement of packaging is to provide a barrier against odours from the surrounding atmosphere entering the packaged orange RTS. This subsection discusses the composition of the aroma fraction in orange RTS and the properties of different polymers and different packages commonly used.

Contribution to typical aromas			**Contribution to off-aromas**
Important	**Desirable**	**Precursors**	**Detrimental**
Ethyl butyrate	Linalool	Linalool	A-terpineol
Neral	Limonene	Limonene	Carvone
Geranial	A-pinene	Valencene	T-carveol
	Valencene		Nootkatone
	Acetaldehyde		Hexanal
	Octanal		T-2-hexenal
	Nonanal		Hexanol

	α-sinensal		4-vinyl guaiacol
	ß-sinensal		2,5-dimethyl-
			4-hydroxy-
			3-(2H) furanone

3.3 Properties of different packages

Aromas can be absorbed into or permeate through the packaging material depending on the type of aroma compound (chemical class, polarity) and the nature of the packaging material. This effect, often called “flavour scalping”, has been extensively studied, especially for laminated carton packages.The absorption and/or permeation of aroma compounds through polymers is based on the general equation that permeation (P) is a product of diffusion (D) and solubility (S), $P = D \times S$. Consequently, only those aroma compounds with high diffusion and solubility coefficients in respective polymers are likely to be lost through permeation or absorption during storage. The solubility of a compound in a polymer can be estimated simply by making use of the fact that “like dissolves like”.

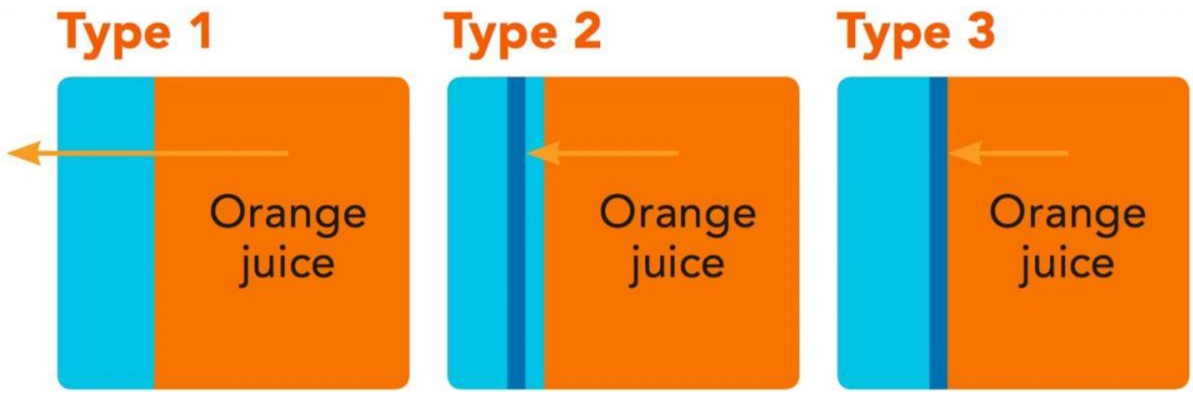
In non-polar polymers, such as polyolefins, non-polar aroma compounds like limonene have high solubility. Low-density polyethylene (LDPE), high-density polyethylene (HDPE) and polypropylene (PP) are examples of polyolefins. While there is a minor difference in solubility for non-polar aroma compounds in the stated polyolefins, their diffusion and consequent permeation rates differ by orders of magnitude in the different polyolefins - in decreasing order LDPE>HDPE>PP. Aroma losses into the polymer layer are therefore significantly slower in PP and HDPE than in LDPE.Unlike non-polar components, polar components such as ethyl butyrate have low solubility in polyolefins. As a result, their permeation rates are very low and losses due to permeation are negligible in barrier packages with LDPE as product-contact layer.Polar polymers like polyester (PET), EVOH and polyamide (PA) basically show very low diffusion coefficients with polar and non-polar aroma compounds. This results in good barrier properties against both types. However, polar polymers are sometimes more difficult to heat-seal than polyolefins.

In summary, aroma losses due to absorption into or permeation through polymer packaging primarily involve non-polar aroma compounds (for example hydrocarbons like limonene) in contact with non-polar polymers (LDPE, HDPE, PP) commonly used as sealing layers. Polar polymers (PET, PA, EVOH) exhibit minimal absorption of aroma compounds and thus provide an effective aroma barrier.

Properties of different packages

The extent of loss of aroma compounds due to absorption or permeation can vary significantly between different package types.

- **Type 1 package** has no efficient aroma barrier (for example carton packages without a barrier layer and monolayer HDPE bottles).
- **Type 2 package** has an aroma barrier not in contact with product, and a sealing layer like LDPE in contact with product. Most laminated cartons are type 2 packages. Also HDPE bottles incorporating a barrier layer belong to this group.
- **Type 3 package** has an aroma barrier in direct contact with product (for example glass and PET bottles).



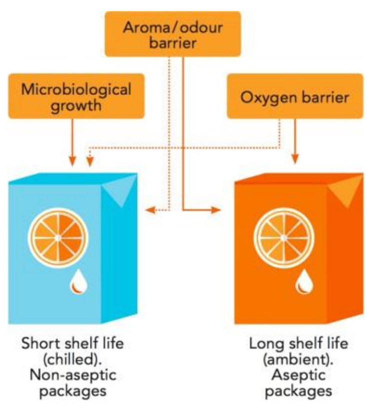
3.3.1 ASEPTIC PACKAGING

For storage at ambient temperature, it is essential that:

- Orange RTS is free from spoilage microorganisms when packed
- Packages do not recontaminate the product
- Packages provide an effective barrier against external microorganisms

Since these conditions are an absolute prerequisite for storage at ambient temperature, product shelf life is not determined by microbiological factors but by quality changes that are due to inevitable temperature-driven reactions and oxidative reactions. The latter are directly related to the package barrier properties.

For RTS under chilled distribution, the situation can be more complicated. Microbial spoilage may become the limiting factor of shelf life depending on the selected heat treatment of the product, hygienic status of the packaging system and storage temperature of filled packages (2-10°C). It is outside the scope of this section to discuss the different options with respect to expected shelf life under chilled conditions, but it is important to understand that the requirements for other barrier properties of a package depend on whether or not product shelf life is limited by microbiological spoilage. For example, if a RTS is spoiled by microbial action after three weeks at 4°C, the aroma and oxygen barrier properties are of minor importance compared with a package where the RTS is spoiled by microorganisms after six weeks or more. In this case, enhanced aroma and oxygen barrier package properties are required to meet the extended shelf life. For aseptically packed RTS, the oxygen and aroma barrier properties of the package determine product shelf life because there is no microbial action.

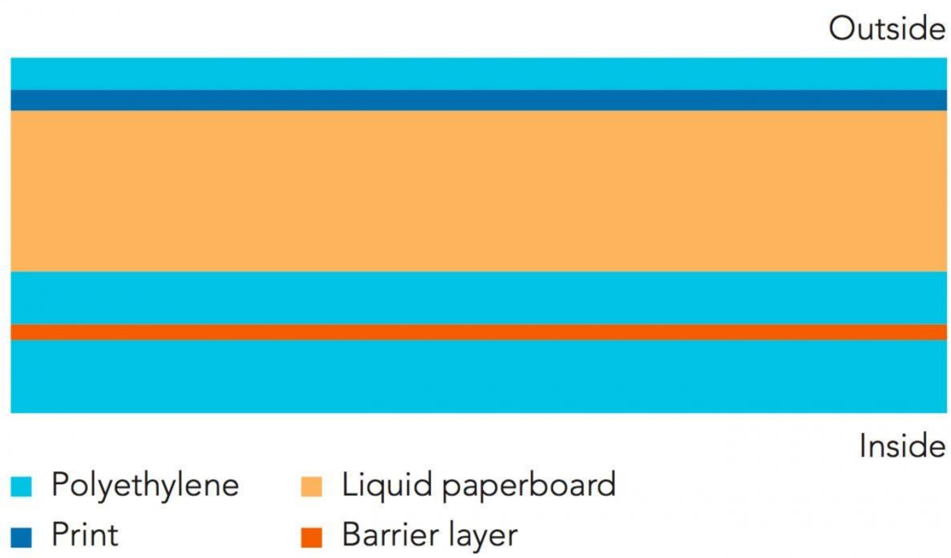


Different packages and packaging systems

Ready-to-drink RTS from concentrate and NFC sold as shelf-stable products are pasteurized and either packaged aseptically or hot filled.

3.3.2 CARTON-BASED PACKAGES

The laminated carton material normally consists of layers of paperboard coated internally and externally with polyethylene, and a barrier layer.The most commonly used barrier layer today is Al-foil. Other barriers include ethylene vinyl alcohol (EVOH) and polyamide (PA). A schematic structure of laminated packaging material for orange RTS cartons is shown below. Depending on the packaging system used, the packaging material is delivered to the RTS packer as prefabricated carton blanks or printed and creased in rolls.Oxygen-barrier properties of a laminated carton package depend not only on the barrier properties of the packaging material itself, but also on the barrier properties of strips and closures and the tightness of seals.



3.3.2.1 Carton-based packages from prefabricated blanks

With prefabricated systems, the blanks are die-cut and creased, and the longitudinal seal is completed at the packaging material factory. The printed flat blanks are delivered to the RTS packing facility, where they are finally shaped and sealed in the filler. Blanks to be used for chilled orange RTS are handled under non-sterile conditions but steps are taken to avoid recontamination of microorganisms. The filling temperature should be low (4-5°C or less) to minimize microbial growth. At these low temperatures the risk of foaming is higher compared with filling at higher temperature. All packages made from prefabricated blanks are filled by leaving a certain amount of headspace. An inert gas like nitrogen can be used to flush the headspace to remove some oxygen and decrease oxidative changes in the RTS during storage. The advantages of a headspace are that pulp-containing RTS can be shaken and that package sealing occurs above the product level, thus preventing floating pulp from getting trapped in the top seal. The filling of RTSs containing floating pulp should be done continuously because separation of the RTS and cells in upstream buffer tanks happens quite fast. To avoid separation, agitation of upstream tanks is sometimes carried out. Care should be taken to prevent agitation from introducing air and gas bubbles into the RTS.

3.3.2.2 CARTON-BASED PACKAGES FROM ROLLS

Packaging materials are supplied in rolls that have been printed and creased. The packaging material roll is fed into a machine, where it is formed into a tube and the longitudinal seal made by a heat-sealing system. In this process, a strip is heat-sealed along the inner surface of the longitudinal seal (LS) to protect the different layers of packaging material from contact with product and vice versa. The oxygen-barrier properties of the longitudinal seal are important for oxygen-sensitive products such as orange RTS.

RTS is poured into the tube and a transversal seal (TS) is made below the level of the orange RTS. This results in headspace-free packages. Alternatively, packages may be produced with a headspace either through nitrogen injection or low-level filling. Packaging without headspace or with an oxygen-free headspace is advantageous for orange RTS and other oxygen-sensitive products because it eliminates a significant source of oxygen and associated quality changes.

Carton-based packages with a polyethylene top are made from roll-fed packaging material as well. In the filling machine the material is cut into sheets, which are folded and longitudinally sealed. The plastic tops are injection-moulded and sealed with the sleeve to form a package. After filling from the bottom, the bottoms are sealed by heating elements.

In an aseptic filling system, the material web is sterilized with hydrogen peroxide (H_2O_2) or by electron beam. Hydrogen peroxide is used either in a wetting system or a deep bath system, after which the H_2O_2 is completely evaporated. In electron beam sterilization, the packaging material passes in front of an e-beam lamp that emits a jet of high-energy electrons that kill microorganisms on the material surface. Less energy is used for e-beam sterilization as heating and drying of H_2O_2 is not required. The subsequent filling and sealing processes are all performed inside a sterile chamber under positive pressure. Seal quality is of utmost importance in aseptic systems to prevent the entry of microorganisms. When filling orange RTS with a high content of floating pulp, special consideration should be given to the transversal sealing.

3.3.3 GLASS BOTTLES

Glass bottles still play an important role in several markets worldwide. For shelf-stable orange RTS in glass bottles, the most common filling method is hot filling. Aseptic filling of glass bottles at ambient temperature is of minor importance compared to hot filling. Of the package types used today for orange RTS, glass bottles are normally considered to have the best oxygen barrier properties. In hot filling, the deaerated and heated RTS is directly poured into cleaned bottles that are capped. The filling temperature is usually between 90°C and 98°C. Preheating of glass bottles is necessary to reduce the risk of glass splintering at filling. The required holding time for capped hot bottles, prior to cooling in a tunnel, depends on the level of microbial contamination of the empty bottles.

The hot product sterilizes the inside surface of the bottle, whereas bottle closures should be sterilized before they are applied to the bottle. Prior to closure, the bottle neck is flushed with steam. Steam injection keeps foaming to a minimum and reduces the oxygen content of the neck space as well as the recontamination risk. Hot filled bottles are frequently overfilled in order to ensure sterilization of the neck by the hot product. Other possibilities for neck sterilization are to tilt the bottle or turn it upside down.

3.3.4 PLASTIC BOTTLES

Blow-moulded plastic bottles are today the dominant bottle type for orange RTS, far exceeding the use of glass bottles. The most common plastic bottles are polyethylene terephtalate (PET) followed by high-density polyethylene (HDPE).

3.3.4.1 HDPE BOTTLES

As HDPE has a poor oxygen barrier, plain HDPE bottles allow relatively high oxygen ingress and are used for chilled RTS of short shelf life only (about three weeks). The oxygen barrier can be improved by adding intermediate layers of polymers with superior barrier properties. The most common barrier layers in HDPE bottles for orange RTS are ethylene vinyl alcohol (EVOH) and polyamide (PA). These also provide an aroma barrier and can allow ambient storage for six months or longer, depending on the choice and thickness of the barrier layer.

HDPE bottles are fairly opaque, often pigmented, and produced by the extrusion blow-moulding (EBM) process. Contrary to PET, HDPE bottles exhibit high thermal resistance and can be hot filled as well as sterilized in autoclaves. With the increased use of aseptic filling, however, ambient orange RTS has shifted from HDPE to transparent PET bottles. In extrusion blow moulding (EBM), the HDPE resin is first melted in a hot screw and pushed through a steel disk (a die) to form a hollow pipe of polymer known as a parison. When the parison is sufficiently long, the two halves of the bottle mould close around it. Then pressurized air blows into the parison so it takes the shape of the mould, thus the bottle is formed. The bottle is blown with a sealed dome that must be cut off before filling.A barrier layer may be incorporated by co-extruding barrier material with HDPE in the parison. Barrier bottles typically comprise six or seven layers, including intermediate tie-layers and regrind material. Bottles with an integrated handle can be made using the EBM process. EBM can also be used to produce PET bottles provided special grades of modified PET resin are employed.

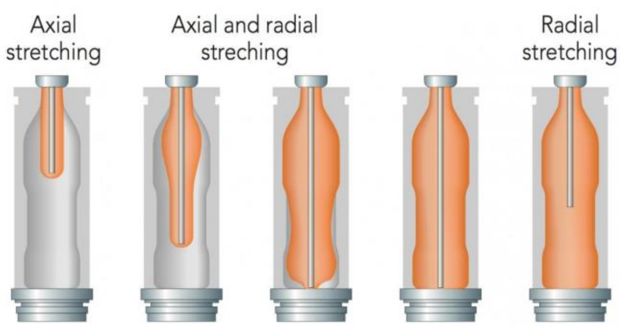
3.3.4.2 PET BOTTLES

PET bottles were introduced in the late 1970s for carbonated beverages. Their use has grown steadily in most beverage applications. Today, they are the most common container for still and carbonated drinks. Orange RTS packaged in PET bottles is found in both the chilled and ambient segments; ambient RTS is either filled aseptically or hot filled. PET bottles are made by stretch blow moulding (SBM), starting with a preform. A preform is an injection-moulded PET tube closed at one end and with the finished neck at the open end. During blowing with high-pressure air, the heated preform is stretched both axially (using a stretch rod) and radially into the bottle mould. The bi-oriented material gives the bottle high tensile strength and an increased gas barrier, which allows for lightweight bottles.

Stretch blow moulding equipment is available for all capacities: from small units for 6,000 bottles per hour to mega-systems producing 100,000 bottles per hour. There are also systems with integrated preform injection and bottle blowing (ISBM), starting with PET resin in-feed and a blown bottle out the other end. In their natural state, PET bottles are transparent and colourless. However it is possible to produce coloured bottles by adding appropriate pigments to the raw PET material.

3.3.4.3 ADDING BARRIER TO PET

The robustness of PET bottles compared to glass is obvious, but they do not provide as good an oxygen barrier as glass. Standard PET bottles give a shelf life for orange RTS of about three to four months; large volume bottles give a longer period. The inclusion of active (oxygen scavengers) and passive barriers in PET bottles may extend shelf life up to 12 months and more.There are three main technologies for increasing PET bottle oxygen barrier properties. All three are applied to orange RTS packaging:



- **Monolayer barrier preform**, where the PET polymer is mixed with an additive compound (such as oxygen scavenger) during preform production
- **Multilayer preform**, with three co-injected layers: PET/barrier material/PET. The barrier material is an oxygen scavenger mixed with PET. Polyamide (PA) is mainly used for CO2 gas retention, and can also be added to the oxygen scavenger.
- **Bottle coating**, using plasma technology to coat the inside of the bottle with a barrier layer. This technology requires an additional machine between bottle blowing and filling.

In many markets, PET bottles are collected and recycled into resin for use in new PET bottles. Compounds added during PET bottle production, including barrier additives, may reduce the quality of recycled PET material.

3.3.4.4 INCREASED HEAT RESISTANCE IN PET

Amorphous (non-crystalline) PET becomes “rubbery” at temperatures above 70-80°C. Hence, regular PET bottles are not suitable for hot filling of orange RTS, which is normally carried out at 84-88°C. To withstand these high fill temperatures, the bottles’ heat resistance is increased by applying special conditions during stretch blow moulding. Such “heatset” bottles are blown in a hot mould to achieve higher crystallinity and minimized stress in the PET material.

When the hot product cools down after filling, a vacuum forms inside the capped bottle because the volume of the liquid decreases and headspace gases are absorbed into the RTS. PET bottles for hot filling are therefore designed with “vacuum panels” (flat surfaces on the side of the bottle) or other features that absorb the volume variations between hot and cold conditions. PET bottles for aseptic filling do not require heat setting as filling takes place at room temperature. They are usually of lower weight than hot fill bottles and allow more freedom in their design as vacuum panels or similar features are not needed. As a result, bottle costs are lower but aseptic filling is more complex and entails a higher capital investment.

3.3.4.5 HOT FILLING

Ambient orange RTS in plastic bottles may be filled aseptically or hot filled. In the US, hot filling is the dominant practice for shelf-stable still beverages, as for orange RTS. At European RTS packers, however, aseptic filling prevails for orange RTS in cartons as well as plastic bottles. In Asia, both systems are employed.Hot filling for the production of shelf-stable orange RTS involves pouring the heat-treated RTS, without significant cooling, directly into the package. The high temperature of the RTS is used to kill microorganisms on the package surfaces. The time period and temperature needed will depend on:

- Microbial contamination of packages and closures
- Number of microorganisms in the surrounding air, production area and filling machine
- Quality requirements for the product
- pH value of the product
- Shape of the package
- Material used for packaging

Glass bottles have to be heated before filling and cooled after filling by means of a cascade system; otherwise the glass will break. PET bottles have the advantage of tolerating immediate exposure to high filling temperatures and cooling rapidly after the hold time needed to kill spoilage microorganisms.

3.3.4.6 ASEPTIC FILLING

Aseptic filling technologies for orange RTS in plastic bottles demand a considerably more complex installation than basic hot filling. Prior to filling with product, the PET (or HDPE) bottles are sterilized using a sterilant such as peroxyacetic acid (PAA) or hydrogen peroxide (H_2O_2). Bottles treated with PAA solution are then rinsed with sterile water, while bottles sterilized with H_2O_2 are dried with sterile air or nitrogen.Several recent aseptic installations feature the sterilization of PET preforms instead of the blown bottles. The advantages of this approach include lower sterilant usage (H_2O_2 vapour) and possibilities to further decrease bottle weight. However, sterile conditions must be guaranteed during bottle blowing and transfer to the filling carousel. It results in a compact installation as SBM and filler are directly connected in a single block.For aseptic filling, the pasteurized RTS is quickly cooled to filling temperature, whereas the time required to cool hot filled RTS to ambient storage temperature is considerably longer. The cooling time depends on the bottle size and type of tunnel cooler.

CHAPTER 4
FSSAI STANDARDS FOR ORANGE RTS

4.1 FSSAI 2.3.10: Thermally Processed Fruit Beverages / Fruit Drink/ Ready to Serve Fruit Beverages

1. Thermally Processed Fruit Beverages / Fruit Drink/ Ready to Serve Fruit Beverages (Canned, Bottled, Flexible Pack And/ Or Aseptically Packed) means an unfermented but fermentable product which is prepared from juice or Pulp/Puree or concentrated juice or pulp of sound mature fruit. The substances that may be added to fruit juice or pulp are water, peel oil, fruit essences and flavours, salt, sugar, invert sugar, liquid glucose, milk and other ingredients appropriate to the product and processed by heat, in an appropriate manner, before or after being sealed in a container, so as to prevent spoilage.

2.3.10: Thermally Processed Fruit Beverages / Fruit Drink/ Ready to Serve Fruit Beverages

2. The product may contain food additives permitted in these regulations including Appendix A. The product shall conform to the microbiological requirements given in Appendix B. The product shall meet the following requirements:—

1. Total Soluble solid (m/m) : Not less than 10.0 percent
2. Fruit juice content (m/m)

a) Lime/Lemon ready to serve beverage : Not less than 5.0 percent

b) All other beverage/drink : Not less than 10.0 percent

3. The container shall be well filled with the product and shall occupy not less than 90.0 percent of the water capacity of the container, when packed in the rigid containers. The water capacity of the container is the volume of distilled water at 20ºC which the sealed container is capable of holding when completely filled.

Food Category System	Food Category Name	Food Additive	INS No	Recommended maximum level	Note
14.1.4.2	Non-carbonated water-based flavoured drinks including punches and ades, ginger cocktail (ginger beer and gingerale), thermally processed fruit beverages/ fruit drinks/ready to serve fruit beverages	Lauric arginate ethyl Ester	243	50 mg/kg	165,188
		RIBOFLAVINS		50 mg/kg	
		SACCHARINS		300 mg/kg	
		L-Tartaric acid	334	GMP	
		Curcumin	100	200 mg/kg	
		beta-Carotenes, vegetable	160a(ii)	200 mg/kg	
		CAROTENOIDS		200 mg/kg	
		Annatto	52[160b (i), (ii)]	200 mg/kg	
		Saffron		GMP	
		Ponceau 4R	124	200 mg/kg	XT99
		Carmoisine	122	200 mg/kg	XT99
		Erythrosine	127	100 mg/kg	XT99
		Tartarzine	102	200 mg/kg	XT99
		Sunset yellow FCF		200 mg/kg	XT99
		Indogotine (Indigo carmine)		200 mg/kg	XT99
		Brilliant Blue FCF		200 mg/kg	XT99
		Fast green FCF		200 mg/kg	XT99
		BENZOATES		600 mg/kg	
		SULFITES		350 mg/kg	XT100

		Propylene glycol alginate		GMP	
		Alginic acid	400	GMP	
		Sodium alginate	401	GMP	
		Calcium alginate	404	GMP	
		Glycerol ester of wood rosin	445(iii)	100 mg/kg	
		Sodium aluminium silicate	554	5 g/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

4.3.1 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.

4.3.2 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.

4.3.3 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;

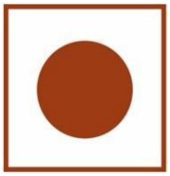
4.3.4 Nutritional Information

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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