MINISTRY OF FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA

Frequently Asked Questions

on

Different Concepts of Food Processing

with Focus on

Ultra Processed Foods (UPFs) and High Fat, Salt and Sugar (HFSS) Foods/Diets

ACKNOWLDGEMENT

Food processing is a science-backed discipline aimed at ensuring safer, more nutritious, and convenient food for consumers. It involves the transformation of raw ingredients into products, supporting enhanced safety, extended shelf life, and improved nutritional value. Rooted in scientific principles, engineering technology and traditional knowledge, food processing relies on disciplines such as microbiology to prevent contamination, food chemistry for preservation and functionality, and food engineering to enable scalable production. In today's fast-paced world, processed foods offer unmatched convenience - be it ready-to-eat meals, frozen snacks, or canned foods, helping individuals manage their time and nutritional needs effectively. However, despite the sector's vital contribution to food safety and accessibility, public perception is often influenced by misinformation and media-driven myths. Concerns related to UPF (Ultra-Processed Foods), HFSS (High Fat, Sugar, and Salt) items, nutrient loss, preservatives, and health implications continue to create confusion among consumers.

Recognizing the need for scientific clarity and public awareness, the Ministry of Food Processing Industries has developed a set of Frequently Asked Questions (FAQs) in association with NIFTEM-Kundli. The draft, prepared after industry stakeholder consultation, addresses these misconceptions and presents science-based information on processed foods. These FAQs aim to foster informed choices and dispel common fears surrounding the sector.

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- **Dr. Harinder Oberoi**, Director, NIFTEM-K – Member
- **Prof. V. Palanimuthu**, Director, NIFTEM-T – Member
- **Dr. Sridevi Annapurna Singh**, Director, CFTRI – Member
- **Dr. Rajesh Khadgawat**, Professor, Department of Endocrinology & Metabolism, AIIMS, New Delhi – Member
- **Ms. Monita Gahlot**, Senior Dietitian, Department of Gastroenterology & Human Nutrition Unit, AIIMS, New Delhi – Member
- **Dr Jitendra P. Dongare**, Dy. Agricultural Marketing Advisor, MoFPI – Member Secretary

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INDEX

Frequently Asked Questions (FAQs)
on
Different Concepts of Food Processing

1. What are processed foods?

A processed food is any food material that has been altered from its original form before it is ready for consumption. The common methods of food processing include heating, pasteurizing, canning, drying, freezing or refrigeration. The International Food Information Council describes processed foods as those that have undergone any deliberate change before consumption [1][2][3]. There is a misconception that all processed foods are nutritionally poor and should be avoided. Scientifically, however, processing is often a crucial step for producing healthy, tasty and safe food sustainable for consumers. Almost every food commodity available in the market is processed to some degree because food begins to deteriorate and lose nutrients as soon as it is harvested. Therefore, it must undergo processing before reaching the consumer [4].

2. What is food processing and why it is important?

Food processing has progressed through the ages, from the use of fire for roasting of meat about millions of years ago, through the development of various methods such as cooking, fractionation, preservation using heat, pickling, fermenting, freezing and drying to present-day 3D food printing [5]. We process food every day while preparing meals for ourselves and our family. From peeling, cutting, chopping to cooking, frying, boiling, etc., there are many steps involved in food processing. However, Industrial food processing is a broader term and refers to the large-scale application of various

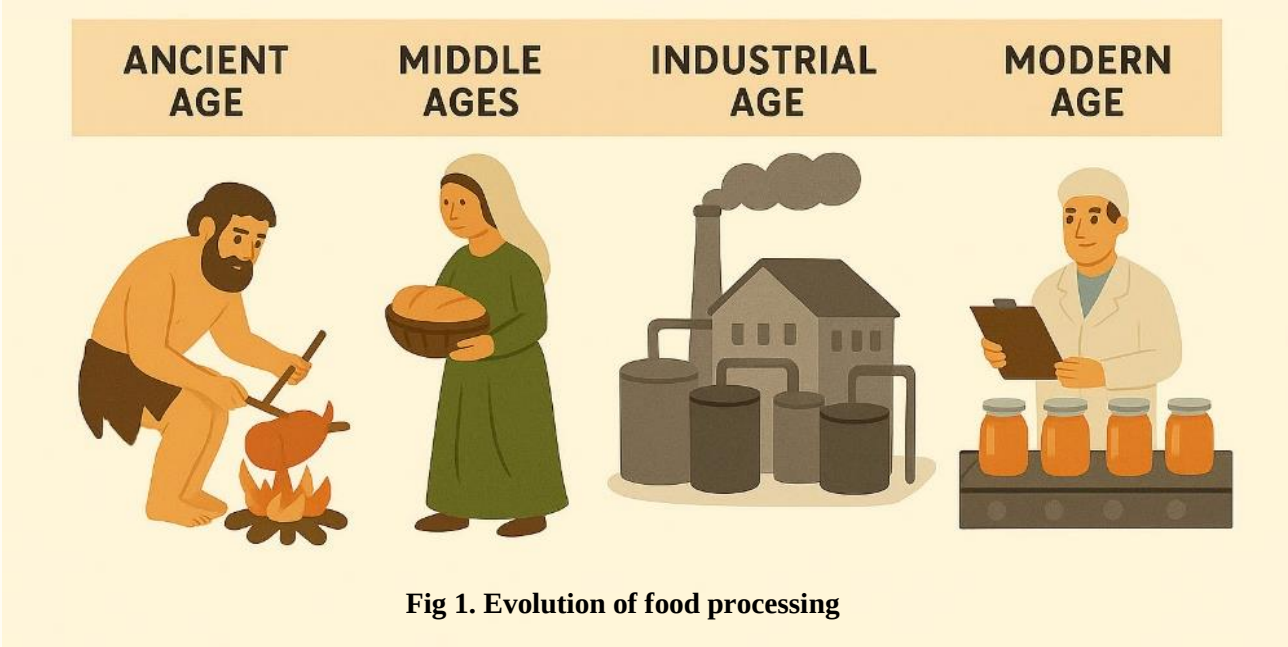


Fig 1. Evolution of food processing

techniques to transform raw ingredients into safe, shelf-stable, and palatable food products [6]. These processes which can involve employees, power, machines and technology to change the original physical properties of the raw products, resulting in an edible product suitable for human consumption and having commercial value. This also includes value-added processes to enhance the shelf life and

quality of food substances [7]. Processing transforms perishable raw materials, which are hardly edible, into nutritious, safe, stable, and palatable foods, providing a pleasing sensory experience and improving convenience. A variety of crops abundantly grown around the globe cannot be consumed if they were not processed [8]. The food processing industry is of enormous significance for India's development due to the vital linkages and synergies it promotes between the two pillars of our economy: industry and agriculture.

2 a) Traditional method of making curd at home

2 b) Fermentation of curd at industrial level

2 c) *Namkeen* making at home – a basic process of food extrusion

2 d) Textured products in industry – an advanced form of food extrusion

2 e) Bread making at home Oven

2 f) Bread making in an industrial oven

Fig 2. Traditional vs. industrial food processing: from home kitchen techniques to modern manufacture

3. What are the benefits of food processing?

If food is not processed, it becomes highly susceptible to microbial contamination leading to increased risk of foodborne illnesses. Unprocessed foods also spoil quickly, resulting in significant post-harvest losses and food waste. Nutritionally, many raw foods such as millets, pulses, and legumes contain anti-nutritional factors, such as phytates and tannins, which can hinder digestion and block the absorption of essential micronutrients like iron, zinc and calcium. Without processing methods like soaking, cooking, fermenting, or drying, these micronutrients remain unavailable. Thus, food processing is not just a modern convenience concept but a vital step to ensure food safety, enhance nutrition and reduce waste. [5] The following are some of the key benefits of food processing. [9] to [19]

- ✓ **Food safety**: Techniques like pasteurisation, sterilisation and irradiation eliminate or control pathogens and spoilage organisms.
- ✓ **Shelf-life extension**: Drying, freezing, vacuum packaging, and canning make food available year-round, especially in remote or seasonal settings.
- ✓ **Reduction in food waste**: By preserving surplus harvest and preventing spoilage, food processing plays a role in reducing food loss and supporting sustainable production and consumption.
- ✓ **Nutritional enhancement**: Processing techniques like dehulling, soaking, fermentation, and germination improve bioavailability and reduce anti-nutrients.

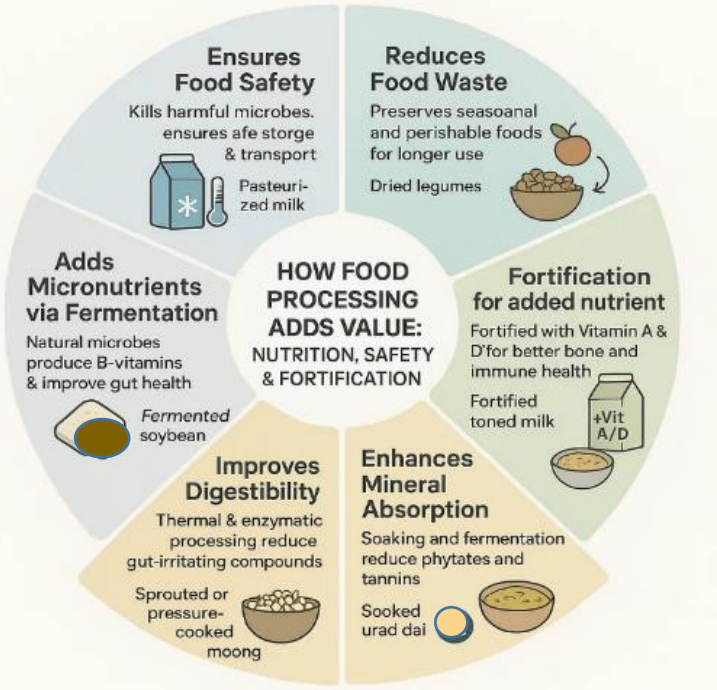


Fig 3. Benefits of food processing

- ✓ **Fortification**: Widely used to address micronutrient deficiencies. Examples:
  - Iodised salt (fortified with iodine) supported in eliminating goitre from the nation.
  - Fortified rice (Iron) and fortified atta (fortified with iron, folic acid) support in reducing the incidence of anaemia
  - Milk (vitamin A & D) and fortified oil (vitamin A & D) help in improving eye and bone health and immunity.
- ✓ **Specialised nutrition**: Processing allows the development of lactose-free milk, gluten-free flours, diabetic-specific foods and medical nutrition therapy products such as Complan, Chyavanprash, Pediasure etc.
- ✓ **Economic and trade benefits**: Enhances export, generates employment and strengthens agri-food value chains.

- ✓ **Food accessibility and diversity**: Provides affordable nutrition in diverse forms, including traditional and ready-to-eat foods.
- ✓ **Food for special requirements** – People working in difficult situations/areas entirely depend upon processed foods; for instance, soldiers working at high altitudes/ borders, space missions, Antarctic expeditions, long-duration sea missions, etc.

4. What are the common misconceptions about the consumption of processed foods?

There are many common misconceptions among consumers that – i) All processed foods belong to a single, unhealthy category ii) Processed foods contain excessive amounts of sugar, sodium and unhealthy fats to enhance flavour and shelf life iii) Processed foods include artificial colours, flavours, sweeteners, preservatives to make them hyper palatable, leading to overeating and poor appetite regulation iv) Processed foods lack dietary fibre and contains artificial ingredients that negatively affect the digestive system v) Processed food is a main cause for Non-communicable diseases and Obesity.

It is not that food processing itself is inherently harmful; in fact, it often improves food safety, extends shelf life, and makes foods more convenient and accessible.[21] Processed foods encompass a wide range of products with varying nutritional qualities. Higher levels of processing do not necessarily mean less healthy. What truly matters is the final nutritional composition of the product, not merely the level of processing. [22]

All packaged foods carry labels providing nutritional information on energy, protein, fat, carbohydrates, added sugars, trans fat and other nutrients. Consumers can make informed choices by reading the information and selecting products that are high in fibre, protein and essential micronutrients. [23] Foods that are high in salt, sugar, or fat should be consumed in limited amounts.[24]

There is also a concern that eating processed foods leads to chronic diseases. However, chronic diseases typically arise from long-term poor dietary patterns and lifestyle choices. [25] Moderation and a balanced diet that includes processed foods can support overall health. [26]

Another frequent worry is that food additives are harmful. Additives are used to enhance food appeal, food safety, extend shelf life, improve nutrient availability and provide convenience, all under strict regulatory limits to ensure safety [27]. There are many health-promoting additives and natural additives like yellow colour from turmeric, orange/red colour from carrot, pink from beetroot, green colour from chlorophyll. Preservatives like lactic acid from fermented sugars, citric acid from citrus fruits, ascorbic acid from citrus or amla, flavours from herbs and spices (vanilla, cardamom, cinnamon, etc), emulsifiers like lecithin from soy, gum from guar beans, pectin from apple/citrus fruit peels, etc.

It is important to recognise the nutritional value that processed foods can offer and dietary advice should focus on the overall quality of the diet and lifestyle. Providing consumers with accurate information empowers them to make healthier and more balanced choices. [28]

5. What are the different levels of food processing?

Food processing encompasses all the steps that food goes through from the time it is harvested to the time it arrives on the consumer's plate. Traditionally, Food processing can be broadly categorised into three levels based on the degree of transformation and the purpose of processing [29].

- **Primary Processing**

  It is the initial process of handling food material immediately after harvest, where raw ingredients are processed into forms suitable for consumption or further processing. This is usually done in the vicinity of the farm itself. Primary processing involves cleaning, grading, sorting, cutting, size reduction, packaging, storage, and refrigeration of raw foods to ensure that foods are not spoiled before they reach the consumer.[30][31]

  Examples: Rice milling, pulse milling, oil milling, flour milling, decortication, washing and grading of fruits & vegetables, grading & packaging of fruits in carton boxes.

- **Secondary Processing**

  It refers to the transformation of primary processed foods into food products that are generally ready to be consumed or sold. This stage focuses on combining multiple food ingredients and employing various processing techniques to create new palatable food items. In transforming the raw materials into finished food items through various processes, it focuses not only on taste and appeal but also on their safety aspects. [30][31] This approach is common as the secondary processing is often employed both at home and in commercial kitchens to produce processed foods.

  Examples: Baking bread from flour, fermenting milk into yogurt, making jam from fruit and sugar, fruit pulps and pastes, cheese or paneer from milk, popcorn from tender corn, sausages from ground meat, ghee from butter etc.

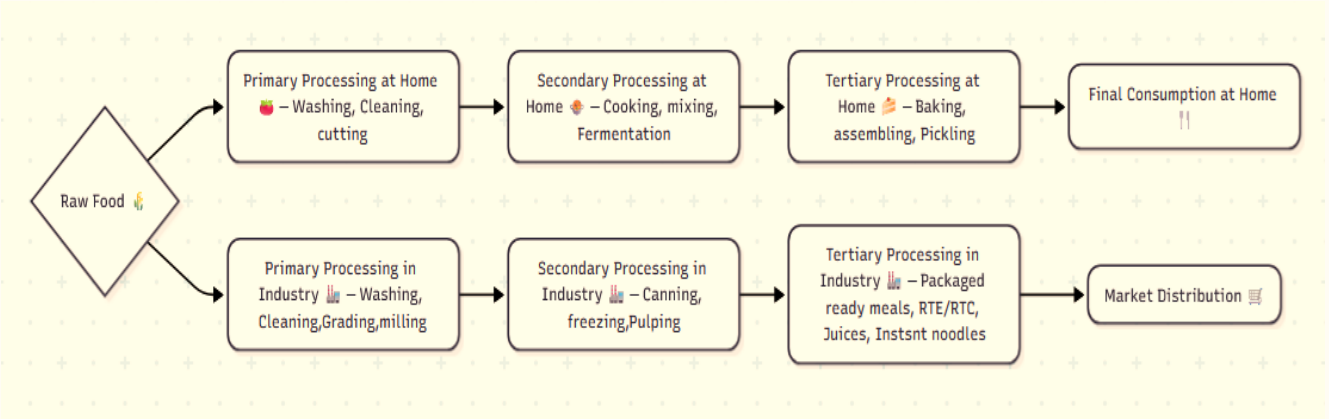


Fig 4. Food processing done at home and at industry scale

- **Tertiary Processing**

  This is the next level of food processing during which the already-processed ingredients are transformed into ready-to-eat (RTE), ready-to-heat (RTH), or shelf-stable products, often with a focus on convenience, shelf life, and mass appeal. This level of processing generally involves

large-scale industrial-level production and may include adding additives and packaging for extended shelf life and easier distribution. This often involves multiple stages of processing, including the use of additives to enhance shelf life, palatability, and convenience [29].

Examples: Instant noodles, frozen pizzas, packaged snacks, breakfast cereals, processed fruit and vegetable products like frozen vegetables, fruits, juices, beverages and powders.

6. Are fresh products especially fruits & vegetables available in the market also processed?

Yes, many fresh fruits and vegetables you see in the market undergo some form of processing, even if they look completely natural. This is done to make them clean, safe and appealing with increased shelf life, without significantly altering their natural form or nutrient levels. Some common processing techniques used for fresh fruits are:

- **Washing & sanitising:** To remove dirt, pesticides, and microbes, fruits & vegetables are washed in clean water and sometimes treated with mild sanitising agents.
- **Sorting & grading:** Fruits are sorted and graded based on size, colour, maturity, weight, etc. to meet market requirements and consumer expectations.
- **Chilling or refrigeration:** After harvest, fruits are kept in cool temperatures to slow down ripening and maintain freshness during transport and storage.
- **Irradiation:** Exposing fruits to a controlled dose of ionising radiation kills bacteria, mould, and insects, and extends shelf life without making the fruit 'radioactive' or unsafe.
- **Modified Atmosphere Packaging (MAP):** Fruits are packed in special films or trays where the air composition inside is adjusted to keep them fresh for a long time.
- **Controlled Atmosphere Storage:** Some fruits (like apples or bananas) are stored in chambers with reduced oxygen and controlled carbon dioxide and humidity to delay ripening.

Fig 5. How are fresh fruits processed before reaching you?

These techniques help ensure that fruits remain safe and are of good quality when transported from farm to table, while retaining their natural flavour and nutrients [32].

7. What are Ultra-Processed Foods (UPFs)?

The term "Ultra-Processed Food" was first proposed in 2009 by Brazilian epidemiologist Monteiro under the NOVA system, a food classifying system that categorizes foods on the basis of degree and purpose of processing. NOVA classifies food into four groups:

- Group 1: Unprocessed or Minimally Processed Foods – Natural foods or those minimally altered without added substances.
- Group 2: Processed Culinary Ingredients – Products extracted from Group 1 foods (e.g., oils, butter, sugar, and salt).
- Group 3: Processed Foods – Products made by combinations of Group 1 and Group 2 foods (e.g., canned vegetables, cheese, and freshly baked bread)
- Group 4: Ultra-Processed Foods – Products made by a series of industrial processes and contain ingredients that are not commonly used in kitchens, such as additives and chemically modified ingredients.

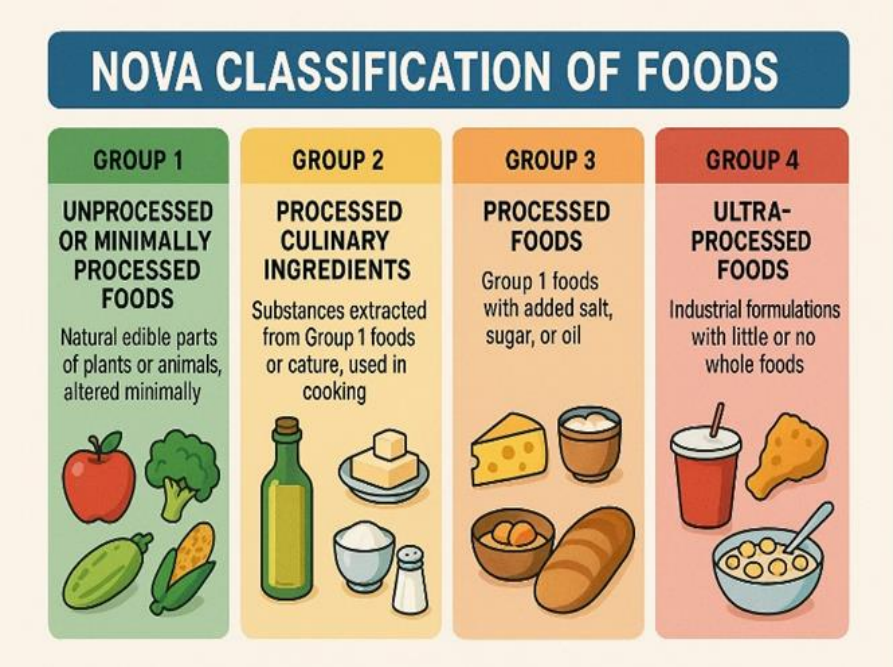


Fig 6. NOVA classification of food

In addition, under the NOVA classification, industrial formulations typically contain at least five ingredients, the food is not usually recognizable from its original form, and they often have high fat, salt or sugar and contain no whole foods. Examples of ultra-processed foods (UPFs) according to the NOVA classification include carbonated drinks, sweet or savouries, packaged snacks, ice creams, chocolates, candies, mass-produced packaged breads and buns, all kinds of biscuits, margarines and spreads, pastries, cakes, breakfast cereals, energy and protein bars, energy drinks, flavoured milk drinks, fruit yoghurts, meat and chicken extracts, instant sauces and soups, infant formulas, protein isolates, and many ready-to-heat products such as poultry and fish nuggets/ sticks, sausages, burgers, reconstituted meat products, noodles, and desserts. [33][34] [35]

A similar definition of UPFs has also been included in the recent *Dietary Guidelines for Indians 2024* issued by ICMR-National Institute of Nutrition, which describes UPFs as food and beverage products that have undergone extensive industrial processing and contain many additives and other substances that are not commonly used in culinary preparations [36]. In addition to the above, UPFs are further classified into A, B, and C categories based on the amount of sugar, salt, and fat. However, the robustness of such definitions is a topic of current debate and requires further research.

8. What is the basis of classifications for Ultra-Processed Foods?

The term "**Ultra-Processed Foods'** is specific to the NOVA classification system and it is now a commonly adopted terminology globally. However, the definition of UPFs is ambiguous in nature. This UPF's definition is solely based on the degree of processing and the number of ingredients used without considering the nutrient profile of the food. This over-simplification has led to significant criticism from scholars, food scientists, and health authorities [37][38].

a) NOVA classifies many healthy foods as Ultra-Processed Foods: The biggest limitation of the NOVA system is its inability to clearly differentiate healthy and unhealthy food items. This classification characterizes several healthy, nutrient-dense foods as UPFs based on processing. For instance, whole-grain bread, fortified breakfast cereals, fruit yoghurt, fortified dairy foods, various foods for special needs like protein isolates, infant formulas, lactose-free foods, plant-based milk, refined and fortified oils, and traditional Indian foods like ready-to-cook idli-dosa batters, spiced buttermilk, or fortified millets may get misclassified. These foods, available in packaged form and as good sources of essential nutrients, are categorised as UPFs [39],[40], creating confusion and disbelief among consumers about their health benefits.

b) Potential cause for confusion: There are various examples of foods (e.g. bread, biscuits, fruit yoghurt, millet-based cookies, dry fruit *ladoos*, and whole wheat pizza bases, pickled products etc), which can be prepared at home or in industrial settings with essentially the same ingredients and using similar processes. The UPF classification applies exclusively to industrially produced foods, while similar products prepared at home, often with the same ingredients and processes, are not considered UPFs [38]. Thus, the ambiguity of the UPF term has the potential for confusion when used for public health messaging. [44]

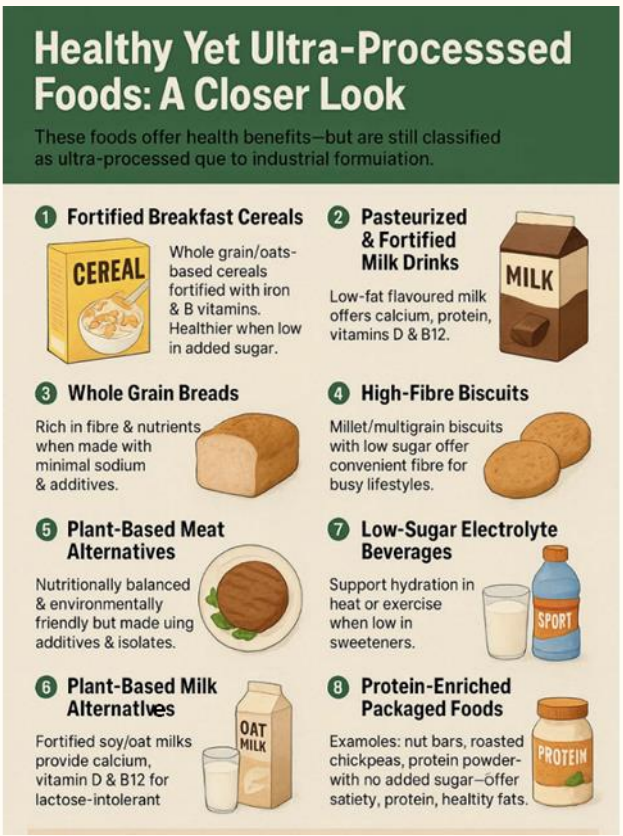


Fig 7. Healthy ultra-processed foods

c) Does not classify food correctly considering nutrient levels: Nova classifies UPFs based on processing; however, it is not possible to determine the processing steps used in the manufacture of foods by seeing the product or its pack, making it difficult to assess which NOVA group they fall into. In several cases, healthcare experts are also not able to correctly classify UPFs using NOVA.[41] When UPFs were compared with other diet and nutrient-based classifications, there were irregularities. It is the final nutritional composition of a product that matters when assessing health, not the level of processing. [42]

d) Potential for undermining the credibility of food preservation: This classification is based on the number of ingredients added, including additives, stating that these additives might have harmful

effects on health. However, these additives are added to perform various technological functions in processed food and are under strict limits. Also, the UPF concept oversimplifies food health impacts and may stigmatize beneficial processing such as pasteurization, fermentation, or fortification [43].

e) Lack of global consensus: The inconsistencies in NOVA classification hinder global consensus on dietary guidelines and policy development. To date, the Codex Alimentarius Commission, which is the International Food Standards Setting Body, has also not defined UPFs. Further, several international food authorities criticized NOVA as this system lacks the scientific robustness required for public health policies or dietary guidelines. Scholars argue that such misclassification risks confusing consumers because nowadays, practically all food is processed in some sense and in some way, and that it could stigmatize innovative food processing technologies aimed at improving nutrition access, highlighting the need for a more nuanced food classification system based on nutrition profiling of food. The evidence-based food classification system that accounts for both the degree of processing and the nutritional quality of foods, along with their role in sustainable food systems, is needed to better guide consumers and policymakers. [45]

9. What role do additives play in processed foods and what is their impact on health?

Food additives are substances intentionally added to food during processing for a technological purposes. This may be to improve shelf life, maintain its nutritional qualities, prevent spoilage during transport, storage, aid in the processing of foods and improve sensorial attributes (taste, texture, appearance) etc. Additives are not normally consumed as a food by themselves [46]. Based on origin, food additives can be from natural or synthetic sources. However, based on the technological function they perform, food additives can be classified as below:

- **Preservatives-** are added to prevent and retard the microbial spoilage of food (lactic acid E270, citric acid E330 etc.)
- **Acidity Regulators-** added to modify or control the acidity or alkalinity of a food and can either alter the texture, taste, or safety of a food (tartaric acid E334, sodium bicarbonate E500, etc.)
- **Antioxidants-** are added mainly in fat and fatty foods to delay or prevent the rancidity of foods due to oxidation (ascorbic acid E300, tocopherol, vitamin E E306-309, etc.)
- **Anticaking agents-** are added to powdered or granulated ingredients to prevent lumping, caking, or sticking (silicon dioxide E551, calcium silicate E552 etc.)
- **Enzymes-** are used for various purposes, such as in baking or cheese making (amylase, protease, etc.)
- **Emulsifiers-** are substances added to form a homogeneous mixture of two or more non-miscible phases, for example, water and oil (lecithin E322, mono- and diglycerides of fatty acids E471 etc.)
- **Flavour enhancers, colouring agents, sweeteners-** to improve organoleptic property of food (MSG E621, disodium inosinate E631, tartrazine E102, aspartame E951, sorbitol E420 etc.)
- **Thickening agents-** to improve the consistency of food (i.e., guar gum E412, pectin E440 etc.)
- **Foaming Agents-** maintain a uniform dispersion of a gaseous phase in liquid or solid food. (egg white proteins, soy lecithin E322 etc.)

- **Leavening Agents-** added to doughs and batters to increase the volume, shape, and texture of baked goods. (sodium bicarbonate E500, ammonium bicarbonate E503 etc.)
- **Humectants-** added to keep foods moist or to retain moisture in food. (glycerol E422, sorbitol E420 etc.)
- **Oxidizing or Reducing Agent-** added to oxidize or reduce another food ingredient (improve flour and promote dough development), thereby producing a more stable product (potassium bromate E924, benzoyl peroxide E928 etc.). [46-49]

Consumers can find information about food additives on product labels, where they are listed under 'ingredients'. They are listed in descending order by weight. Sometimes consumers have a poor perception about additives that they impose a health risk; however, FSSAI regulates the use of food additives through the Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011[47]. For each additive, the Acceptable Daily Intake (ADI) (the amount that can be consumed daily over a lifetime without adverse health effects) is established. FSSAI also guides FAQs and other documents to clarify regulations and address common questions. Safety of food additives is also assessed by the Joint Expert Committee on Food Additives (JECFA), an expert body of international scientists commissioned under FAO-WHO. There are well-standardized methodologies, such as risk assessment, in place to assess the safety of food additives by using laboratory models. The food processing industry abides by the Good Manufacturing Practice (GMP) for the use of food additives as specified in regulations.[46][47]. The addition of food additives in processed food is to serve one or more of the technological functions and must not mislead consumers.

Fig 8. Food additive classifications

10. What is the impact of food processing on nutrient loss and how are they mitigated?

Industrial food processing offers numerous benefits such as enhanced food safety, extended shelf life, and increased accessibility. However, processing may affect the nutritional value of some foods. Understanding these losses and how to minimize them is crucial for a healthy diet. Thermal processing methods like boiling, canning, pasteurization and baking can degrade heat-sensitive nutrients such as minerals, vitamin C and some B vitamins and folate. Vitamin C can also be lost during drying. Exposure to air, especially during processing and storage can also cause the oxidation and loss of vitamin C and vitamin A. Commercial juices are often filtered and strained, removing nearly all fibres.

Mechanical processes like peeling, milling, and refining of whole grain/ flour can remove the outer layers (bran) of grains which are rich in fibre, B vitamins, and minerals. Fat-soluble vitamins and minerals are comparatively more stable during processing. Nutrient losses from heat-labile vitamins and unwanted chemical reactions are more severe with longer exposure to elevated temperatures, but proper process control and formulation can help mitigate these effects. [50 to 52]. The food processing industry minimizes nutrient losses by using various strategies and innovative technologies, ultimately providing consumers with processed foods that are both safe and nutritionally valuable.[53] to [55] These are as follows:

- **Optimizing Processing Parameters:** Controlling temperature, time, and pressure during processing to achieve desired results with minimal nutrient degradation.
- **Vacuum Drying and Freeze-Drying:** These methods can help retain nutrients during drying.
- **Freezing:** Rapid freezing, especially with Individual Quick Freezing (IQF) technology.

  helps retain the nutritional value of foods, particularly seafoods, vegetables, and fruits, by minimizing ice crystal damage and slowing down enzymatic and chemical reactions.
- **Fermentation:** Fermentation processes can increase the bioavailability of certain nutrients by lowering anti-nutrient (e.g. phytates) levels and promoting beneficial probiotics.
- **Modified Atmosphere Packaging (MAP):** Controls the gaseous environment in packaging to reduce oxidation and maintain nutrient stability.
- **High-Pressure Processing (HPP):** This non-thermal method uses high pressure to inactivate microorganisms and enzymes while preserving heat-sensitive nutrients.
- **Pulsed Electric Field (PEF) Processing:** Uses short bursts of high-voltage electricity for microbial inactivation, offering a gentler alternative to thermal processing and better nutrient retention.
- **Fortification & Enrichment:** Adding back nutrients lost during processing (enrichment) or deliberately adding nutrients to enhance the nutritional value (fortification) can compensate for losses.
- **Enzyme Control:** Inactivate nutrient-degrading enzymes through pH alterations or blanching.
- **Gentle Cooking Methods:** Prioritize steaming or stir-frying over boiling to minimize nutrient loss. Steaming, for instance, can retain significantly more Vitamin C compared to boiling.
- **Proper Storage:** Store foods properly, such as keeping cold foods cold and sealing some foods in airtight containers to minimize nutrient degradation.

It is important to note that food processing, be it at home or at an industrial level, is not innately harmful and often provides significant benefits: it improves food safety by killing pathogens, extends shelf life, enhances palatability and digestibility, and increases the availability of seasonal or perishable foods [56]. Even home cooking involves processes like boiling, frying, and baking, which can cause similar nutrient losses and reactions. Therefore, the health impact of processing depends on how the food is processed, the frequency of consumption and the overall dietary pattern. [57]

11. What are the some common suggestions to safeguard the nutrients in processed food?

Some of the suggestions to reduce the undesirable effects of some processing methods are given below:

- **Lower frying temperatures and shorter times** can reduce acrylamide and trans fat formation [58]. (Acrylamide is a potentially harmful chemical that forms in starchy foods when they are cooked at high temperatures (above 120 °C), especially by frying, roasting or baking)
- **Avoid repeated use of frying oil**, as it increases the formation of trans fats and degradation products like 3-MCPDs (3-monochloropropane-1,2-diol, a chemical substance found in many food items).[59] Trans fats are the unsaturated fats or fatty acid transformation due to repeated boiling of oil for frying and the reuse of the same oil for frying. Trans fats are harmful to heart health.
- Use **gentler cooking methods** such as steaming to retain nutrients [60].
- **Limit baking and roasting** of starchy foods at high temperatures or use pre-treatments like blanching to reduce acrylamide precursors.
- **Read labels** to avoid foods with partially hydrogenated oils (a source of industrial trans fats).
- Prefer **fortified foods** (e.g. iron-fortified flour, Vitamin A, D fortified milk, oil, iodised salt) to address micronutrient deficiencies.
- Water-soluble vitamins and minerals can leach into cooking water during boiling. Using **minimal water and incorporating it into gravies, soups or sauces** can help retain these nutrients.
- Nutrient degradation can also occur during storage, especially under conditions of light, heat, and oxygen. **Storing food in cool, dark, and dry environments in appropriate packaging** helps maintain nutritional quality.
- Some loss of nutrients during processing is inevitable; **consuming a varied diet rich in fruits, vegetables, whole grains, pulses & legumes, and quality proteins** compensates for any reductions [61].

The ICMR approach focuses mainly on nutrient adequacy; it encourages fortification and recommends a diverse diet. [62][63]

12. What are HFSS foods and how are they classified?

According to the ***ICMR-NIN Dietary Guidelines for Indians 2024***, HFSS foods include foods and beverages, whether packaged or unpackaged, that are high in saturated fats, added sugars, or sodium. These foods are typically energy-dense and might be low in fibre and essential nutrients.

Specific examples frequently cited in Indian contexts include:

- Deep-fried snacks (samosas, puris)
- Bakery items (cakes, biscuits, cookies)
- Namkeen, instant noodles
- Sugary drinks, desserts
- Bakery products, frozen meals, canned fruits, and Indian sweets

Frequent consumption of HFSS foods increases risks of non-communicable diseases such as obesity, diabetes, hypertension, and cardiovascular conditions [62] and it is important to identify HFSS foods. ICMR defines threshold values of energy, added sugar, added fat (used for cooking) and salt for 100 g cooked or packaged food, are given in the table below:

Nutrients per 100 g or ml	Liquids (ml)	Solids (g)
Energy (kcal)	70	250
Added salt (mg)	175	625
Added sugar(g)	2	3
Added Fat (g)	1.5	4.2

Table 1. Nutrients of concern and their threshold criteria in foods and beverages as prescribed by ICMR, NIN 2024 dietary guidelines

As per ICMR recommendations, the nutrient threshold criteria apply to all cooked/packaged foods and beverages with added sugar, added salt, or added fat. Liquids include any product, such as all beverages, fruit juices, coconut water, butter milk, lassi, coffee, and tea. For solid foods: threshold for sugar has been calculated at ~5% energy from added sugar and not exceeding 10% energy from total sugar. The threshold for fat has been calculated at ~15% energy from added fat and not exceeding 30% energy from total fat. For liquid foods/ beverages: Threshold for sugar has been calculated at ~10% energy from added sugar and not exceeding 30% energy from total sugar (including naturally present sugar in fruit juices/milk, etc.). The threshold for fat has been calculated at ~15% energy from added fat and not exceeding 30% energy from total fat[62].

In addition, ICMR further classifies HFSS food into 3 categories within the level of processing and based on the level of added fats, sugar, and salt (HFSS). Food category 1 indicates energy, fat, sugar, and salt within normal levels from 100 g of food eaten. While categories 2 and 3 indicate moderate and higher levels of energy and fats or sugar or all along with excessive salt. Categories 2 and 3 fall under HFSS foods.

The Food Safety and Standards Authority of India (FSSAI) has issued advisories[65] to limit the consumption of foods high in fat, sugar, and salt (HFSS). However, regulatory gap persists because FSSAI has yet to formally define HFSS under its Labelling and Display Regulations. This lack of a precise definition or identification process poses a challenge in effectively regulating the consumption of these foods. MOFPI advises limiting the consumption of HFSS food, whether prepared at home, eaten outside or packaged ones, especially those that are lacking in essential nutrients. Food labels on processed food are an important tool to identify HFSS food and make informed choices.

13. What are the common public misunderstandings about processed and HFSS Foods?

Many people believe that all processed foods are inherently unhealthy and should be avoided. This misconception arises because “processing” is often equated with excessive sugar, salt, fat, and chemical additives, even though many processing techniques (e.g. pasteurisation, freezing, fortification) improve food safety, nutritional quality, and shelf life [36]. Similarly, the classification of certain foods as HFSS (high fat, sugar, salt) often fails to distinguish between nutrient-poor ultra-

processed snacks and nutrient-dense, culturally significant foods that may also be high in natural sugars or fats, such as dried fruits, nuts, or whole milk preparations. [70]

There are several **common misgivings or misconceptions** among the general population about processed and HFSS foods, which often lead to confusion or fear. These include:

- **All processed foods are unhealthy -** Many people believe that all processed foods are bad for health which is untrue. Food processing ranges from minimal (e.g., pasteurized milk, frozen vegetables) to highly processed (e.g., snacks, sugary cereals). Many processed foods are healthy, enhance safety, shelf life and nutrition rich profiles. However, when consumed occasionally and in controlled portion as part of a balanced diet, they may not be harmful.
- **HFSS foods are toxic or dangerous –** There is a misconception that HFSS foods are harmful or toxic. The truth is that only excessive consumption is linked to health risks.
- **Processed foods contain only artificial ingredients -** People often assume processed foods are full of chemicals or artificial additives. While some ultra-processed foods may have natural additives, many processed foods are nutritious and safe. People may also wrongly assume that the presence of food additives automatically makes a product unsafe; in reality, additives are strictly regulated, thoroughly tested, and used in safe quantities to enhance food quality and safety.
- **Natural or homemade means healthy -** There is a belief that anything homemade or labelled “natural” is automatically healthy, even if it is high in fat, sugar, or salt (e.g., homemade sweets, pickles, or fried snacks). Healthfulness depends on the nutritional profile of the final product not just origin.
- **Labelling and marketing mislead consumers -** Many people are unaware of how to interpret food labels and are misled by marketing terms like "low-fat," "sugar-free," or "organic," assuming such products are always healthy—even if they are still HFSS.
- **HFSS foods are the sole cause of lifestyle diseases -** While HFSS foods may contribute to non-communicable diseases, the causes are multifactorial, including sedentary lifestyle, lack of physical activity, stress, tobacco, alcohol consumption, pollution and overall poor dietary habits.
- **Processed foods lack nutritional value -** Many processed foods are enriched or fortified with essential nutrients (e.g. iron, vitamin D, folic acid) and contribute positively to dietary intake when chosen wisely.

Overall, these misconceptions can lead consumers to unnecessarily avoid safe, nutritious, and affordable processed or packaged foods while continuing other unhealthy dietary habits. To address these misgivings, nutrition education, transparent labelling, and public awareness campaigns would be key to helping individuals make informed food choices based on science rather than fear or misinformation.

14. In the context of HFSS foods, would it be better to mention added sugar, rather than total sugars, clearly on the label?

The **added sugars** refer to sugar and sugar syrups added to foods and drinks over and above what is naturally/ inherently present in food during processing and preparation and they include sucrose (table sugar), jaggery, honey, glucose, fructose, dextrose, etc. Naturally occurring simple sugars refer to those sugars inherently present in foods, such as monosaccharides which are simple sugars with single sugar molecules, such as glucose or fructose in fruits [62].

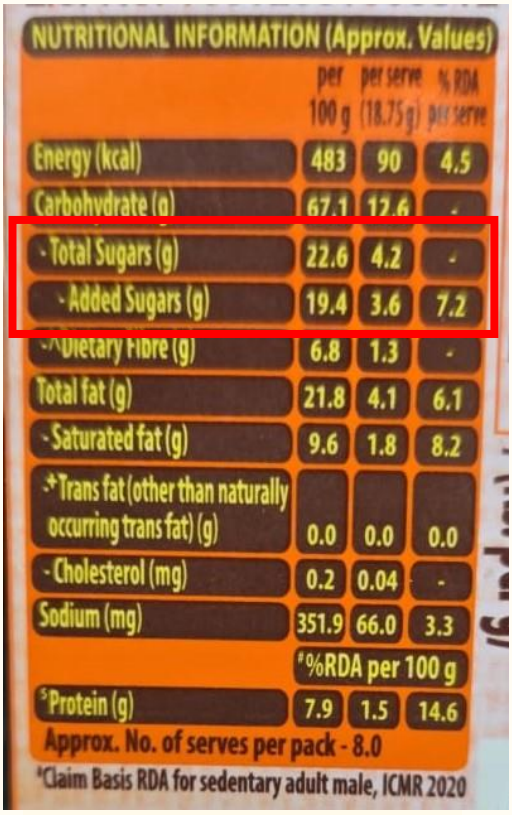


Fig 9. Food label depicting nutritional facts

The current HFSS definition classifies a food as high in sugar if more than 10% of its energy comes from total sugar, without differentiating between naturally occurring sugars (like those in fruits, milk) and added sugars (like table sugar or syrup added during processing). This approach has limitations because not all sugars are equal in terms of health impact. Naturally occurring sugars in whole foods like fruits (fructose) and dairy (lactose) come packed with fibre, vitamins, minerals, and beneficial phytochemicals, which slow down the absorption and contribute positively to health [67]. On the other hand, added sugars increase energy density without adding nutrients. Another issue is that it is not possible to analytically distinguish added sugars from naturally occurring sugars in a laboratory test, especially in processed foods where ingredients like fruit purées, honey, or milk solids are used. This means the HFSS calculation based on total sugar can misrepresent the nutritional quality of foods. Therefore, considering only total sugar rather than focusing on added or free sugars may unfairly categorise nutritious foods as unhealthy while ignoring the context of the whole diet and the source of the sugar. A more nuanced approach that accounts for the type and source of sugar would better reflect the healthfulness of foods.

15. What scientific methods can be used to detect or quantify added sugar, salt, and fat in foods?

Detection and quantification of total sugar, salt (sodium), and fat (saturated/total) in foods require validated, standardised analytical techniques. These methods are routinely employed in accredited food laboratories, certified by agencies such as FSSAI, NABL, AOAC International, and align with Codex standards. However, it is important to note that while laboratories can accurately measure the total content of these nutrients. Currently, there is no validated laboratory method to distinguish added forms from naturally occurring sugars, fats, or sodium in complex food matrices. Identifying added components typically relies on ingredient declarations, recipe/formulation records, and regulatory documentation rather than direct analysis.

A summary of recognised scientific methods used to quantify total nutrients is listed in the table. These techniques ensure reliable, reproducible measurements of total nutrient content, which are essential for nutrition labelling, quality control, and regulatory compliance. However, distinguishing

between added vs naturally occurring nutrients remains a challenge that depends on transparent labelling and manufacturer disclosure rather than analytical chemistry alone.

Table 2. Summary of recognised scientific methods used to quantify total nutrients

Nutrient Component	Analytical Method	Application	Standards & References
Total Sugar	HPLC (High-Performance Liquid Chromatography)	Quantifies glucose, fructose, sucrose in foods	AOAC 977.20 / 984.22, FSSAI Manual
Total Sugar	ICUMSA Methods	Sugars in syrups, fruit drinks, and beverages	ICUMSA, Codex Stan 234-1999
Sodium (Salt)	AAS / ICP-OES (Atomic Absorption / Optical Emission Spectroscopy)	Measures total sodium in food samples	AOAC 984.27, FSSAI Manual
Sodium (Salt)	Ion Chromatography	Precise determination of ionic sodium	AOAC, Codex Stan 234-1999
Total Fat	Gravimetric Method	Measures total extractable fat	AOAC 996.06 / 2003.05
Saturated/Trans Fat	GC-FID (Gas Chromatography with Flame Ionisation Detector)	Profiles fatty acids, including saturated and trans fats	AOAC Methods, FSSAI Manual

16. Can HFSS foods be a part of balanced diet?

Yes, HFSS foods can be part of a balanced diet**,** but only in controlled portions and with careful planning. A balanced diet emphasizes nutrient-dense foods like fruits, vegetables, whole grains, lean proteins, and healthy fats.[66] [67]. HFSS foods—such as sweets, salty snacks, fried items, sugary drinks, and processed fast foods—are high in calories. Consuming them occasionally or in small portions does not necessarily harm health, especially when the overall diet is rich in fibre, vitamins, minerals and healthy fats. Occasional intake of foods high in fat, sugar, or salt is not principally harmful, especially when balanced with nutrient-dense choices and an active lifestyle. The key lies in portion control, frequency of consumption and making informed choices guided by nutritional labels and public health recommendations.[68] Encouraging awareness, rather than restriction, fosters more sustainable and realistic eating behaviours. Public health guidelines generally recommend limiting

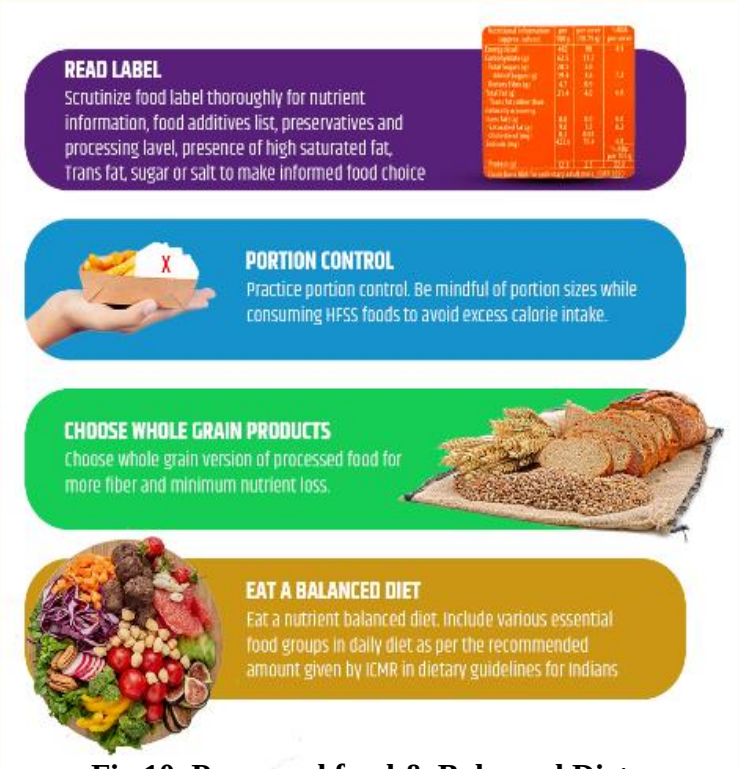


Fig 10. Processed food & Balanced Diet

HFSS foods, particularly in children's diets, while promoting awareness of portion size, reading nutrition labels, and maintaining an active lifestyle [69]. HFSS foods are seen as occasional treats rather than staples in a healthy, balanced diet. A balanced diet enhances nutrient adequacy, supports better satiety, lowers the risk of diet-related non-communicable diseases, and allows for occasional HFSS or ultra-processed food consumption without compromising overall dietary quality. Promoting dietary variety encourages balanced eating habits that are more realistic and culturally appropriate than strict avoidance [69].

17. How does the food industry reduce acrylamide content in processed food items?

Acrylamide is a chemical *(classified as a probable human carcinogen by IARC)* that can form in some plant-based foods during high-temperature cooking, such as frying, roasting, and baking. Acrylamide forms through a natural chemical reaction between sugars and asparagine, an amino acid, in plant-based foods – including potato and cereal-grain-based foods. Common foods with acrylamide are potato chips, French fries, toasted bread, cookies, and coffee. Reducing acrylamide levels in foods may reduce potential human health risks from exposure to acrylamide.[71][72] The food processing industry uses various strategies to minimize acrylamide formation and ensure food safety [71] to [74]

Fig 11. Strategies to reduce acrylamide

- **Temperature & Time Control:** Cooking at lower temperatures and for shorter times reduce acrylamide formation.
- **Use of Asparaginase enzyme:** Converts free asparagine to aspartic acid, reducing acrylamide by up to 90%.
- **Raw Material Selection**: Using low-sugar, low-asparagine varieties of potatoes or grains.
- **Pre-Treatments:** Blanching or soaking raw materials reduces sugar and asparagine content.
- **Formulation Adjustments:** Adding acids (citric acid, vinegar) or reducing sugars to lower acrylamide risk.
- **Use of Whole Grains Carefully**: Balance nutritional value with risk by optimizing process parameters.
- **Process Optimization & Monitoring**: Using HACCP and sensors to monitor temperature and product colour.
- **Compliance with Regulations**: Food industry follows FSSAI, Codex, and EU guidelines for acrylamide control in processed foods.

18. What are Non-Communicable Diseases (NCDs)?

Non-communicable diseases (NCDs) are diseases that cannot be transmitted from one person to another, as they are not caused by an infectious agent. For example, tuberculosis is a communicable disease as it can spread from one person to another by coughing, but diabetes is a non-communicable disease, as it cannot spread from one person to another. NCDs include cardiovascular disease (heart disease), Cerebrovascular Accidents (Stroke), Malignancies (Cancer), Diabetes Mellitus, and COPD, i.e., Chronic Obstructive Pulmonary Disease (Chronic lung disease). Further, these five NCDs share five major risk factors that are associated with the causation of these diseases. These five risk factors are tobacco use, physical inactivity, harmful use of alcohol, unhealthy diets, and air pollution. These five NCDs are collectively responsible for almost 74% of all deaths worldwide and account for seven out of the ten leading causes of death worldwide. Apart from these five prominent NCDs, there is a long list of other NCDs that may also affect health but do not contribute significantly to total deaths.

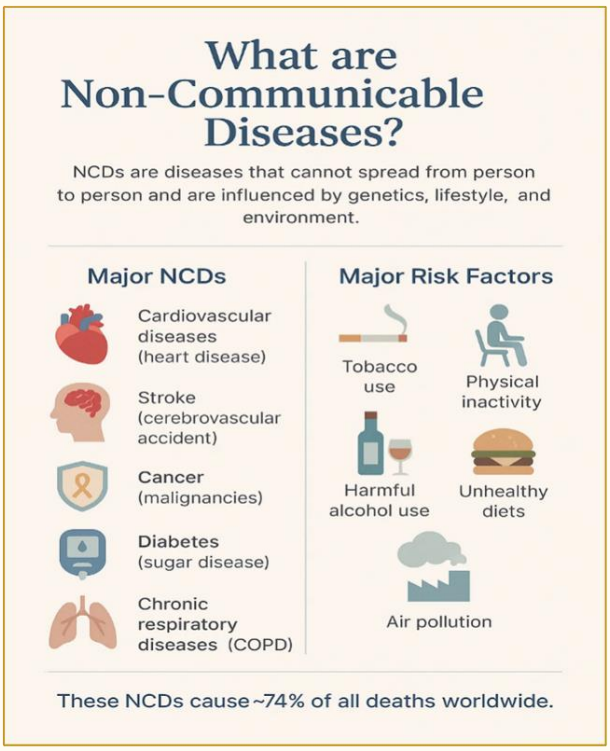


Fig 12. Non-Communicable Diseases

19. Can Non-Communicable Diseases (NCDs) be prevented?

Yes, most non-communicable diseases (NCDs) can be prevented, because they are largely driven by modifiable risk factors such as unhealthy diet, tobacco use, harmful use of alcohol, physical inactivity, and exposure to air pollution (WHO, 2021). Addressing these risk factors can significantly lower both the risk of developing NCDs and the number of deaths they cause.

Adopting a diet rich in fruits, vegetables, legumes, whole grains, nuts, and healthy fats, combined with regular physical activity and avoidance of tobacco and alcohol, can prevent or delay the onset of type 2 diabetes, hypertension, stroke, and certain cancers. Maintaining a healthy weight, managing stress, and ensuring good air quality further support prevention efforts. Importantly, prevention is not only about avoiding the disease entirely; it also helps reduce the severity, improve outcomes, and enhance quality of life for those already living with NCDs. As the WHO emphasises, controlling risk factors and promoting healthier environments are among the most cost-effective and impactful strategies to combat the global NCD epidemic.

20. What is the role of diet and HFSS foods in causing Non-Communicable Diseases (NCDs)?

A healthy diet is one of the most important factors for good health, proper growth, and the prevention of diseases. A diet rich in whole grains, fruits, vegetables, legumes, and nuts and low in salt, added sugar, and unhealthy fats helps prevent all forms of malnutrition and lowers the risk of non-communicable diseases (NCDs) like heart disease, diabetes, stroke, and cancer. On the other hand, eating too much food high in fat, salt, and sugar (HFSS foods), especially in place of a balanced and

varied diet, has been linked to a higher risk of obesity, diabetes, high blood pressure, and other NCDs. This is why organisations like the World Health Organisation (WHO) and many national governments use nutrient profiling to identify HFSS foods and set rules for how they are marketed, particularly to children.

However, it is important to remember that NCDs do not have just one cause. These conditions result from a combination of factors, including poor diet, lack of physical activity, stress, inherited genetic traits, and environmental factors. Overeating HFSS foods, particularly in a monotonous and unbalanced diet, can contribute to these diseases, but blaming HFSS foods alone oversimplifies the problem.

In India, the data show that processed and packaged foods make up less than 12% of the adult diet much lower than in the US or Europe, where it can exceed 50–60%. The rising rates of NCDs in India seem to be more strongly linked with lifestyle changes such as reduced physical activity, higher screen time, urban stress, and socio-economic challenges than just processed food alone. To reduce the risk of NCDs, it is best to focus on an overall healthy lifestyle: eat a diverse, nutrient-rich diet; limit HFSS foods; stay physically active; and manage stress. Occasional consumption of HFSS foods is unlikely to cause harm if the overall dietary pattern remains balanced and healthy.

21. Can Ultra-Processed Foods Lead to Non-Communicable Diseases (NCDs)?

Multiple studies have linked the consumption of Ultra-Processed Foods (UPFs) to an increased risk of Non-Communicable Diseases (NCDs), such as obesity, type 2 diabetes, cardiovascular diseases, and certain cancers. However, it should be noted that these studies have highlighted that it is the high levels of added sugars, unhealthy fats, and salt present in UPFs, which contribute to chronic health issues and not just the level of processing.[75][76] [77].

The health impact of processed foods depends not just on how they are processed but also on **what is consumed, how often, and in what quantities**. A balanced diet with diverse foods, including fruits, vegetables, whole grains, legumes, and lean proteins, alongside moderate, mindful consumption of processed foods, remains the key to good health.[78],[79] However, the definition of UPFs under various classification systems remains ambiguous and often groups nutrient-dense, culturally significant, and fortified foods into the same category as truly unhealthy products. This ambiguity can distort study results and mislead consumers by unfairly labelling healthier options as harmful. It is therefore crucial to first establish a clear, scientifically robust definition of UPFs that distinguishes between processing methods and nutritional quality, enabling better research, policy, and dietary guidance. [80]

22. What are the various categories of food developed for special nutritional or dietary purposes by the food processing industry?

The food processing industry is actively responding to shifting consumer preferences for healthier and more sustainable food options.[81] The idea of producing foods with boosted functionalities of inherent components has led the food industry to a surge of research activities and the development of new ingredients, bioactive compounds, and specialized foods that are found to be associated with beneficial outcomes in health and diseases [82] to [84]. Serving the health and wellness sectors, the food processing industry is producing a wide range of specialized products for health benefits. All these specialized products are regulated under the Food Safety and Standards (Health Supplements, Nutraceuticals,

Food for Special Dietary Use, Food for Special Medical Purpose, and Prebiotic and Probiotic Food) Regulations, 2022, [FSSAI (Nutra) Regulations, 2022] [85].

Type of food covered under [FSSAI (Nutra) Regulations, 2022]

These regulations cover foods specifically processed or formulated for nutritional or dietary purposes, distinguishing them from foods for normal consumption due to their unique composition. They apply to individuals over 2 years of age and include five sub-categories described below:

i. **Health supplements (HS)**:

These are concentrated sources of nutrients (like proteins, minerals, vitamins, amino acids) and/or other ingredients with nutritional or physiological effects, singly or in combination, whose purpose is to supplement the normal diet and not intended to treat or cure any deficiency. **Examples-** Multivitamins, Multi-mineral, protein supplement, etc.

ii. **Nutraceuticals (Nutra)**:

The nutraceuticals are meant to provide a physiological benefit and help maintain good health and are not intended to treat or cure any medical condition, disease, or disorder. This includes molecules/ isolates/extracts as specified in regulations. Nutraceuticals are basically various bioactive compounds that may have anti-inflammatory, antioxidant, immune-enhancing, and various other roles depending on the research that a particular compound has undergone [86][87]. Examples: Glucosamine, Glutathione, Melatonin, Quercetin concentrate, Beta carotene concentrates, fish oil, Isoflavones (genistein, daidzein), Omega-3, Resveratrol, Tocopherols, Citrus bioflavonoids, CoQ10 from non-GM source, and Ubiquinol, etc.

Fig 13. FSSAI regulations 2022

iii. Food for Special Dietary Use (FSDU):

These are specially processed or formulated to satisfy particular dietary requirements that exist because of a particular physical or physiological condition and/or specific diseases and disorders. This standard applies to all prepackaged foods for special dietary uses, in case of weight management, obesity, diabetes, high blood pressure, pregnant and lactating women, geriatric population, celiac disease, sleep management, food for sportspersons and other health conditions. **Examples-**meal replacement formulas for obesity, high fibre supplements for diabetes, gluten-free foods for celiac disease, lactose-free and plant-based milk for lactose-intolerant persons, whey protein isolates, BCAA, oral rehydration solutions for sports persons, etc. [88]

iv. Food for Special Medical Purpose (FSMP):

These are specially processed or formulated for the dietary management of patients and may be used only **under medical supervision**. They are intended for the exclusive or partial feeding of

patients with limited or impaired capacity to take, digest, absorb or metabolize ordinary foodstuffs or certain nutrients contained therein, or who have other special medically-determined nutrient requirements, whose dietary management cannot be achieved only by modification of the normal diet, by other foods for special dietary uses, or by a combination of the two. **Examples-** Elemental or semi-elemental formulas for patients who have malabsorption, High protein, complete, diabetic specific, renal specific, liver specific, formula to be used in a hospital setting for providing exclusive nutrition through a Ryle's tube to critically ill patients.

v. Prebiotic and Probiotic Food (Pre-Pro):

a) **Prebiotic Food:** These are non-viable food components that confer health benefits by modulating gut microflora. As per regulations amount should not be more than 40g/day for adults. **Examples**- Partially Hydrolysed Guar Gum, Inulin, Soya poly-saccharides, Fructo-oligosaccharides, Pectin, etc.

b) **Probiotic Food:** The foods with added viable microorganisms, which, when consumed in adequate amounts, confer health benefits. The minimum viable number of added probiotic organisms in food shall be ≥108 CFU in the recommended serving size per day. **Examples of species used**: Lactobacillus acidophilus, *Lactiplantibacillus plantarum*, *Limosilactobacillus reuteri*, etc, as mentioned in regulations.

Delivery format & ingredients

The products covered may be in the form of powders, granules, tablets, capsules, liquids, semi-solids, drops, pills, gummies, jelly, or other forms as mentioned in the regulation.
The products shall contain approved ingredients as specified in regulations.

Labelling and Claims

The Products should not **claim to cure, prevent, or mitigate any specific disease, disorder, or condition.** Front label should mention categories like "HEALTH SUPPLEMENT/ NUTRACEUTICAL/ FOOD FOR SPECIAL DIETARY USE/ FOOD FOR SPECIAL MEDICAL PURPOSE / PREBIOTIC FOOD /PROBIOTIC FOOD". The label should contain the statement **"NOT FOR MEDICINAL USE**". In addition, the label should have information on the recommended level, added nutrient detail with amount, duration of usage, any warning, side effects or contraindications if any [89].

23. How can consumers make informed decisions when buying packaged food items?

Consumers can make **informed decisions** when buying packaged food items by following a few key tips that help assess the **nutritional quality, safety, and suitability** of products. Reading Front-of-Pack Nutrition Labelling (FOPNL), Nutritional Information on the back of the pack, awareness about serving sizes, and an understanding of the Recommended Dietary Allowances (RDA) are essential. [88]
Here are some tips:

✓ **Read the Nutrition Label Carefully**

- **Check the "Per Serving" Information:** Understand what quantity the values are based on.
- **Look at Calories, Fat, Sugar, and Sodium:** Compare with daily limits; high levels may indicate an HFSS product.

- **Watch for Added Sugars and Saturated Fats:** Even "healthy-looking" products may be high in these.
- **Look for Fiber and Protein:** These are beneficial nutrients and should ideally be higher.

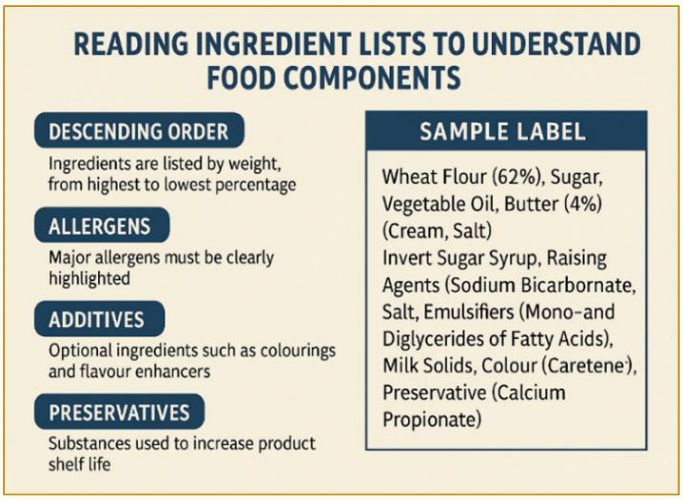


Fig 14. How to understand ingredients in foods

✓ **Understand the Ingredient List**

- Ingredients are listed in descending order **of quantity.**
- Be informed of - **Hidden sugars** (e.g., glucose syrup, maltose, corn syrup etc), **Artificial additives with INS number** (e.g., preservatives, flavour enhancers, synthetic colours), Salt and oil content.

✓ **Don't Be Misled by Marketing Claims**

- Be sceptical of claims like "low-fat," "sugar-free," "Home Made," or "natural"—these don't always mean healthy.
- If label claims "Almond beverage", "hazel nut cookies/ biscuit" etc., then check its actual content (in %) in the ingredient list.
- Check if the product compensates for one reduced nutrient by increasing another (e.g. low-fat but high-sugar).

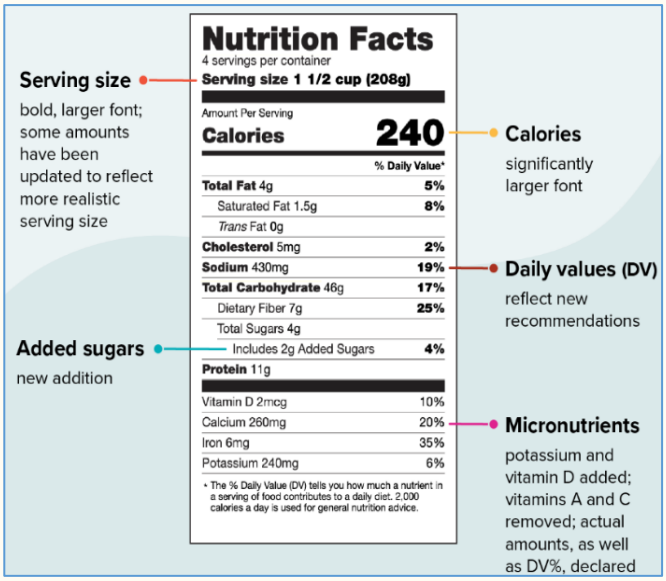


Fig 15. Decoding of food label

✓ **Choose Certified Products**

- Look for **FSSAI license number**, **Organic** or **fortification logos** (e.g., fortified with iron, vitamin D) indicate added nutritional value.
- Look for other certification with logo like Agmark, BIS, Vegan, Irradiated products.
- Quality Certification (HACCP, ISO22000, FSSC) indicates Quality & safety assurance.

✓ Consumers should also check the **nutritional information panel** on the back of the pack, which gives more detailed data on the amount of each nutrient per serving and per 100 g. Being aware of appropriate serving sizes is equally important, as many packages contain multiple servings and eating the whole package may result in consuming much more fat, sugar, or salt than intended.

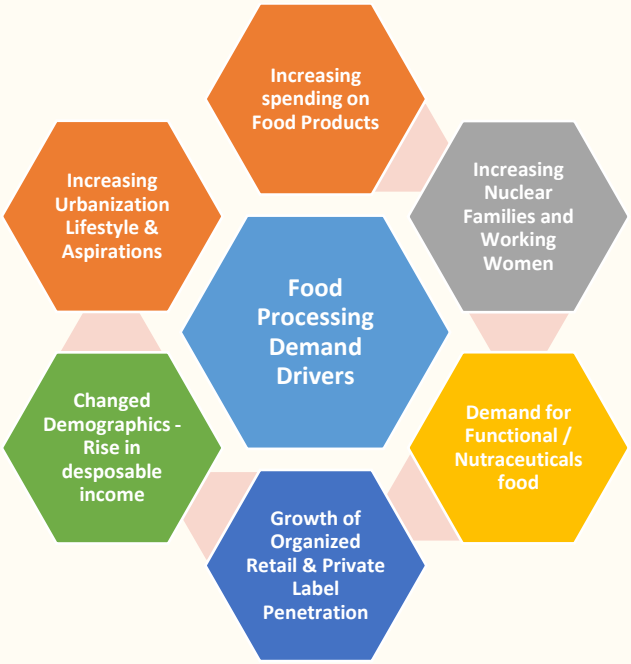
✓ Understanding **Recommended Dietary Allowances (RDAs),** which indicate how much of each nutrient is appropriate for daily intake can help consumers put the label information into context and avoid exceeding healthy limits.

In addition to the above, knowing different methods of food processing may also help consumers in making informed choices. For further details, you can refer to the guidance provided in the **Annexure**, which explains the various methods of processing and their benefits, components of food labels and how to apply them for daily food choices.

24. What is the contribution of Food Processing Sector in the Indian Economy?

Over the years, agricultural production in India has consistently recorded higher output. India ranks first in pulses & milk, second in fruits & vegetable production, wheat, rice, and egg production. An abundant supply of raw materials, an increase in demand for food products, and incentives offered by the Government have influenced the food processing sector positively. During the last 8 years ending 2022-23, the food processing sector has been growing at an annual growth rate of around 5.3 % as compared to around 4.46% in the Agriculture & Allied Sector (at 2011-12 prices). The Food Processing Sector is pivotal in the Indian economy by acting as a vital link between agriculture and industry. It contributes significantly to employment generation, value addition, and export earnings, accounting for nearly 7.66% of India's Gross Value Added (GVA) in manufacturing and 8.45% of the agriculture sector in 2022-23 (at 2011-12 prices). The food processing industry has the highest number of factories and engages the largest number of persons as compared to the other sector industries.

Also, the Food Processing Industry figures among the top five sectors with respect to output and GVA. As per the Annual Survey of Industries (ASI) for 2021-22, the total number of persons engaged in the registered food processing sector was 20.68 lakhs. Unregistered food processing sector supported employment to 51.11 lakh workers as per the NSSO 73rd round, 2015-16. It constituted around 12% of total employment in the organized manufacturing sector and 14.18% of employment in the unregistered manufacturing sector. It enhances farmers' income by reducing wastage and providing market linkages. India, being one of the largest producers of fruits, vegetables, dairy, and grains, has vast potential in food processing, which also attracts substantial Foreign Direct Investment (FDI). Moreover, the sector supports rural development, promotes entrepreneurship through MSMEs, and strengthens food security by improving shelf life and the availability of nutritious food.



ANNEXURE

Food processing technologies play a key role in enhancing both the safety and nutritional quality of food. The details can be seen in the following illustrations:

- **Freezing** slows microbial growth and enzymatic degradation while retaining vitamins and antioxidants.

Example: Frozen vegetables like peas, spinach, and corn retain colour, nutrients, and texture. Freeze-drying mushrooms enhances vitamin D_2 synthesis under UV exposure, acting as a novel biofortification strategy. [44]

- **Thermal processing** methods like pasteurisation, blanching, and sterilisation ensure microbial safety and improve nutrient bioavailability.

Examples: Pasteurised milk, canned dals, and microwave-reheated meals are safer and more convenient. Blanching vegetables like peas, green beans, and cauliflower inactivates enzymes, preserves colour, and extends shelf life. Heat also enhances lycopene in tomatoes. [45]

- **Non-thermal technologies** such as high-pressure processing (HPP) and pulsed electric fields (PEF) preserve heat-sensitive nutrients and extend shelf life without compromising sensory quality [46][47].

Examples: HPP is being explored for mango and pomegranate juices; PEF and pulsed UV light enhance vitamin D_2 in mushrooms and improve safety in dairy and vegetables. [48]

- **Milling** improves digestibility and utility by converting whole grains and pulses into flour, enabling diverse food applications.

Example: Wheat into atta, pulses into *besan* or *sattu*.[49]

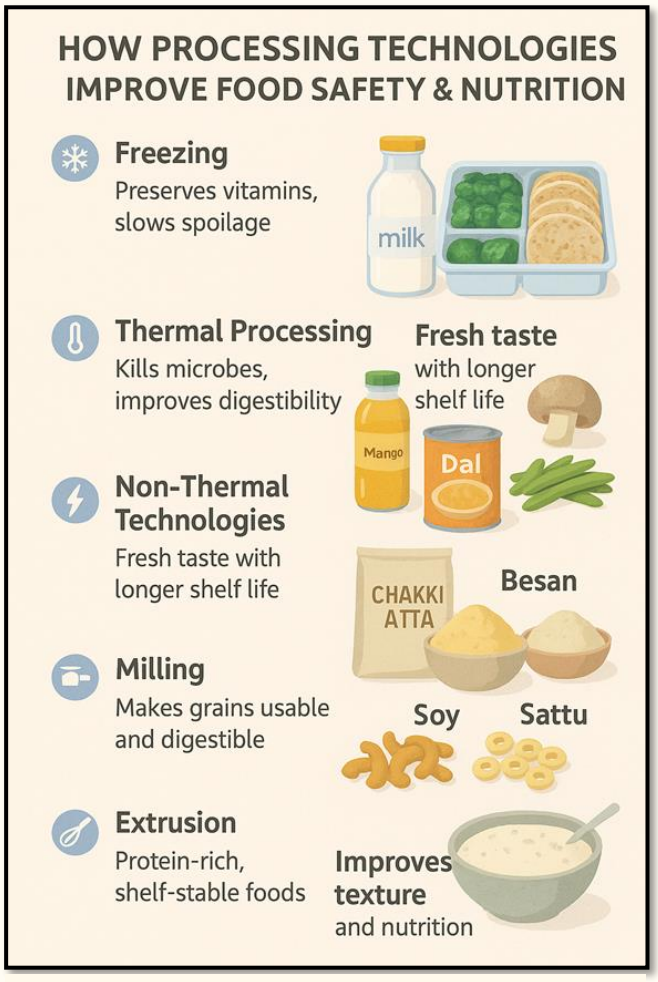


Fig 16. Food processing techniques helps in improving the food safety and nutrition

- **Extrusion** combines heat, pressure, and shear to enhance protein digestibility and produce shelf-stable products.

Example: Fortified soy snacks used in school feeding programmes. [50]

- **Aeration**, especially when paired with fermentation, improves the texture and palatability of foods like idlis and dhoklas.

Example: Aerated batters result in soft, digestible traditional foods. Further, deaerating certain foods supports in dissolved gases, contributing to the prevention of oxidation and improved product stability [51].

These technologies, whether traditional or novel, help maintain the **nutritional integrity, safety, shelf life, and appeal** of perishable and processed foods.

Fig 17. Benefits of thermal and non-thermal processing

1	Cereals and millets	Rice, wheat, millets and other cereals, etc.	
2	Pulses	Lentil, green gram, chickpea, rajma, cowpea, etc.	
3	Vegetables	Seasonal vegetables	
4	Nuts, oil seeds, oils and fats	Peanuts, walnuts, almonds, pistachio, hazel nuts, and other nuts, vegetable oils, etc.	
5	Green leafy vegetables (GLV)	Seasonal GLVs	
6	Fruits	Seasonal fruits	
7	Dairy	Milk, curd and butter milk	
8	Roots and tubers	Beetroot, radish, carrot, tapioca, sweet potato, etc.	
9	Flesh foods	Marine fish, poultry and lean cut meat	
10	Spices and herbs	Turmeric (haldi), ginger, mustard, pepper, cumin, corriander (dhania), etc.	

Fig 18. Food Groups as per NIN, ICMR

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