



PM Formalisation of Micro Food Processing Enterprises Scheme

Processing of Minimally Processed and Frozen Cauliflower



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CHAPTER 1

INTRODUCTION

1.1 Introduction

Processing activities are of critical importance to expansion and diversification within the fresh produce sector as they increase market opportunities and add value while minimizing postharvest losses. Furthermore, processing improves the viability, profitability and sustainability of fresh produce systems by increasing farm incomes, and generating rural employment and foreign exchange. Primary processing technologies such as thermal processing (bottling and canning), freezing, dehydration (salting, brining and candying) drying, and fermentation are widely applied in the processing of vegetables at various levels. Canned vegetables, tomato paste, purees and pulps and dried mushrooms are examples of vegetable products produced using primary processing technologies and which are increasingly entering in international trade. Dried and canned mushrooms produced in China, currently account for 52% of world trade in processed mushrooms. Shelf-life extension of vegetables is a major technological need to overcome the postharvest losses owing to their perishable nature. In recent years, there has been a considerable increase in the demand for processing of vegetables, coupled with convenience and safety.

1.2 Present Status of National and Global Beverage Market

The combined production of broccoli and cauliflower in the world was about 24.2 million metric tons (MMT) in 2014. Minimal processing is a growing processing trend that offers the consumer, convenience, “freshness” of quality, nutrition, and safety. Consumers have also become more critical of the use of synthetic additives to preserve food or enhance characteristics such as colour and flavour. Minimal processing technologies, specialized packaging and natural preservation systems are increasingly being applied in the preservation of vegetables for both developed and developing country markets, in response to growing consumer demand for convenience and for fresh cauliflower of high quality which are nutritious, flavorful and stable. These processing technologies focus on adding value with comparatively little product transformation while increasing product diversity. While minimal and traditional

processing technologies present considerable opportunities for innovation and vertical diversification in the fruit and vegetable sector, relatively few small and medium enterprises (SMEs) are able to tap into and benefit from these opportunities.

Many SMEs lack the capacity to operate competitively in the current globalized market environment owing to problems of scale, the poor quality of input supplies, poor access to technology, limited technical expertise and research capacity, low production. Minimally processed foods can be kept safe with partial or minimal preservation treatment. In addition, it results fewer possible alterations to the food quality. As it involves removing or reducing the natural barriers to deterioration, it offers scientists an enormous challenge in trying to extend the shelf life of minimally processed fresh produce. However, the consumer demand for minimally processed products, changes in perception of the consumers for “freshness” of quality of fresh cauliflower produce, and the convenience of such products warrant further research and developments in this area.

1.3 Effect of Minimal Processing On Nutrition

In addition to sensory attributes, nutritional and health functional components also determine products' key quality parameters. These further rely on the climatic conditions, harvesting operations, and methods of harvesting as well as the processing steps used, such as cutting, shaping, packaging, speed of operations as churning, cooling, and mixing. Functionality of the treated products is largely dependent on the bioactive compounds and antioxidant capacity.

1.3.1 Microbial safety of fresh-cut minimally processed fruits and vegetables

During peeling, cutting and shredding, the surface of the produce is exposed to the air and to contamination with bacteria, yeasts and moulds. In minimally processed fruits and vegetables, most of which fall into the low acid range category (pH 5.8-6.0), high humidity and the large number of cut surfaces can provide ideal conditions for the growth of microorganisms. The populations of bacteria found on fruits and vegetables vary widely. The predominant microflora of fresh leafy vegetables are *Pseudomonas* and *Erwinia* spp., with an initial count of about 10⁵ cfu g⁻¹, although low numbers of

moulds and yeasts are also present. During cold storage of minimally processed leafy vegetables, pectinolytic strains of *Pseudomonas* are responsible for bacterial soft rot. An increase in storage temperature and carbon dioxide concentration in the package will shift the microflora towards lactic acid bacteria. The high initial load of microbes makes it difficult to establish the cell number threshold beyond which the product can be considered spoiled. Many studies show that a simple correlation does not exist between spoilage chemical markers such as pH, lactic acid, acetic acid, carbon dioxide, sensory quality and total microbial cell load. In fact, different minimally processed vegetable products seem to possess different spoilage patterns in relation to the characteristics of the raw materials. Because minimally processed fresh vegetables are not heat treated, regardless of additives or packaging, they must be handled and stored at refrigerated temperatures, at 5°C or under in order to achieve a sufficient shelf-life and microbiological safety. Some pathogens such as *Listeria monocytogenes*, *Yersinia enterocolitica*, *Salmonella* spp. and *Aeromonas hydrophila* may still survive.

1.3.2 Key requirements in the minimal processing of fruits and vegetables

- Raw material of good quality (correct cv. variety, correct cultivation, harvesting and storage conditions)
- Strict hygiene and good manufacturing practices, HACCP
- Low temperatures during working
- Careful cleaning and/or washing before and after peeling
- Water of good quality (sensory, microbiology, pH) used in washing
- Mild additives in washing for disinfection or browning prevention
- Gentle spin drying after washing
- Gentle peeling
- Gentle cutting/slicing/shredding
- Correct packaging materials and packaging methods
- Correct temperature and humidity during distribution and retailing

1.3.3 Application of Non-Thermal Methods in Minimal Processing

Non-thermal processing techniques are emerging in the food industry. These techniques are extended their potential to food preservation with limiting losses of the nutritional and sensory characteristics. These are high hydrostatic pressure, pulsed electric fields, high intensity pulsed light, pulsed white light, high power ultrasound, oscillating magnetic fields, irradiation, and microwave processing. All these techniques have provided a reliable alternative for processing of liquid foods, such as beverages, juices, soups, purees along with solid whole fruits and vegetables and packaged foods. Numerous reports have been published on the high hydrostatic pressure and pulsed electric fields for inactivating the lethal micro-organisms and enzymes. Apart from their microbial inactivation, these are used to extract bioactive compounds, such as polyphenols, flavonoids, hydroxycinnamic acids and. These are termed as non-thermal methods & temperature of processing remained within 30-55 °C. The low temperature safeguards the heat labile components, such as vitamin C, and pigments (e.g. carotenoids).

1.3.4 Pulsed electric field processing

The concept of treating foods with pulsed electric fields was introduced in 1960. Initially the technique was confined to kill microorganisms with optimized parameters such as electric field, pulse shape, pulse width and treatment time. In PEF processing, food products are subjected to a high voltage electrical field such as 20-70 kV/cm for a few microseconds. Earlier the principle of electroporation was proposed stating puncturing the cell membrane of the organisms. Afterwards, PEF was tested on the juices instead of the buffer solutions to inactivate the microorganisms and to have the increased shelf life of juices. PEF technology inactivates or kills a number of vegetative bacteria however; it is not effective to inactivate the spores at ambient temperatures. During the last decade, the new scope of PEF has been evolved for enhanced mass transfer.

PEF was advanced for inactivating or killing of organisms in the juices to an accepted level, and it was diverted to apply for retaining the nutritional parameters. Since PEF is one of the nonthermal processing techniques, the temperature remains

between 30 and 50 °C that enables the significant retention of nutrients. There are several reports, which described the potential of preservation or pasteurization of a variety of liquid foods; however, it still seems premature to recommend its use in fresh cut fruits and vegetable products.

1.3.5 High pressure processing (HPP)

It is also referred to “high hydrostatic pressure processing” or “ultra-high pressure processing”, in which the elevated pressures (up to 600 MPa), with or without the addition of external heat (up to 120 °C), is used to achieve microbial inactivation or to alter food attributes without affecting flavor compounds and vitamins. It is mainly based on the inactivation of the microbial and enzymatic spoilage by exerting pressure. High pressure induces stress on the membranes and prevents them to come in their active state. However, the microbial resistance to pressure varies significantly as per the range of the applied pressure and temperature, treatment period, and types of microbes. It also effects texture of the foods and various researchers are in the process of overcoming hindering aspects in order to make usage of the HPP technology. Interestingly, HHP is used to restructure the food proteins and it results in denaturation, aggregation or gelation of the protein. The microbial infection and enzymatic browning have been identified as major challenges in fresh cut processing, which directly influence the consumers’ acceptance.

HPP inactivates vegetative microbial cells at ambient temperature conditions without affecting the nutritional and sensory qualities. Enzymes such as polyphenol oxidase (PPO), peroxidase (POD), and pectin methylesterase (PME) are highly resistant to HPP and are at most partially inactivated under commercially feasible conditions, although their sensitivity towards pressure depends on their origin as well as their environment. Polygalacturonase (PG) and lipoxygenase (LOX) on the other hand are relatively more pressure sensitive and can be substantially inactivated by HPP at commercially feasible conditions. The retention and activation of enzymes such as PME by HPP can be beneficially used for improving the texture and other quality attributes of processed fruit and vegetable products as well as for creating novel structures that are not feasible with thermal processing. Natural

1.3.6 Antimicrobials

Although synthetic antimicrobial and antioxidant agents are approved in many countries, the use of natural safe and effective preservatives are in demand by the consumers and producers. Therefore, many European and Asian countries are exploiting natural ingredients that can protect the food against the deterioration. There are a great number of natural antimicrobials derived from animal, plant, and microbial sources.

The bioactive functional compounds known as secondary metabolites, obtained from plant sources, are considered as good alternatives to synthetic antimicrobial and antioxidant food additives. These constitute polyphenols, tannins, and flavonoids, which are mostly derived from plants and their antimicrobial and antioxidant in vitro effects have been reported in many publications in the last decade. The antimicrobial and antioxidant properties of bioactive molecules are mainly due to their redox properties, ability to chelate metals, and quenching reactive species of singlet oxygen.

Compounds can either be coated or sprayed on the food products for their quick absorption and action. It is also important to keep the desired sensory properties when additives are used. However, the selection of the plant sources to extract these compounds must be guided for the safe use of food additives. Some key issues must be considered during the application of these natural antimicrobial agents into food products. The form of the antimicrobial, the type of food, storage conditions, types of processes used, and the target microorganism(s) are some of the important factors that could affect the efficacy of these agents.

1.3.7 Edible films and coatings

Another method for extending the postharvest storage life of fruits and vegetables is the use of edible coatings, that is, thin layers of material that can be eaten by the consumer as part of the whole food product. The idea is not new; edible films were already in use in 12th-century China for citrus fruit. However, once the minimal processing of foods started to gain popularity and it was recognized that packaging

should be minimized for environmental reasons, interest in edible coatings increased significantly throughout the world. At least theoretically, edible coatings have the potential to reduce moisture loss, restrict the entrance of oxygen, lower respiration, retard ethylene production, seal in flavour volatiles, and carry additives that retard discoloration and microbial growth.

Some patented and commercially available edible film solutions are those based on sucrose polyesters of fatty acids and the sodium salt of carboxymethylcellulose delayed water loss or browning; those based on cellulose derivatives retarded the discoloration of cut mushrooms, and the development of a physiological disorder of peeled carrots known as white blush. Carrageenan and chitosan coatings are also new coatings that have shown good shelf life extension for minimally processed fruit and vegetables.

1.4 Cauliflower

Cauliflower is important vegetable crop of India known for its curd colour, texture and quality and has great potential in domestic and export market. Its peak period of harvesting falls between November and mid-December resulting in glut of produce in the market and farmers are forced to sell their produce at very low prices. The estimated post-harvest loss of cauliflower per hectare in India is 49%. Hence, there is a need to store cauliflower at recommended storage conditions (0} 1°C, 90-95% RH) with appropriate packaging technique so that it can maintain its quality during storage till it reaches to consumer.

Cultivation

Cauliflower requires fertile, loose, moist, well-drained soil with significant organic matter, good water-holding capacity and pH ranging from slightly acidic to neutral (5.5-7.0). Sandy loams are good for earlier crops while loams and clay loams are ideal for late crops. Cauliflower requires high magnesium levels for good growth.

Harvest, Postharvest Handling and Storage

Heads of cauliflowers are harvested when the curd is regular in shape, medium in size (15-25 cm in diameter), firm, compact, globular, and smooth in appearance. Curd solidity is one of the important factors that determine quality of cauliflowers. The time from tying the outer leaves to harvesting varies from 4-5 days during warm and 14-21 days during cool periods. Depending on the variety and the growing conditions, cauliflower is ready for harvest after 90-120 days of planting. Late harvesting results in over mature curds, which appear loose with uneven spaces commonly known as *ricy* curds. The curds are properly sorted out and stored in the shade to prevent browning (pale yellow to blackish-brown) due to sun's ultraviolet rays.

1.4.1 Health Importance of cauliflower

- May support a healthy heart
- May support healthy brain function
- Rich in sulforaphane
- May support hormonal balance
- May support the immune system

1.4.2 Nutritional content of cauliflower

Nutrients/100 g	Raw Cauliflower	Cooked Cauliflower	Frozen Cauliflower
Moisture (%)	92.07	93.00	92.51
Energy (Kcal)	25.0	23.0	24.0
Protein (g)	1.92	1.84	2.01
Fat (g)	0.28	0.45	0.27
Carbohydrate (g)	4.97	4.11	4.68
Dietary fiber (g)	2.0	2.30	2.30
Sugars (g)	1.91	2.08	2.22
Potassium (mg)	299.0	142.0	193.0
Sodium (mg)	30.0	15.0	24.0
Calcium (mg)	22.0	16.0	22.0
Iron (mg)	0.42	0.32	0.54
Vitamin A (IU)	NA	12.0	12.0
Vitamin C (mg)	48.2	44.0	48.8
Niacin (mg)	0.507	0.410	0.429
Folate (µg)	57.0	44.0	64.0

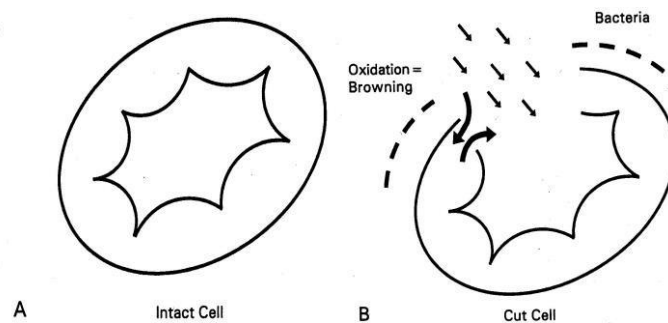
Source: USDA (2017).

CHAPTER 2

PROCESSING OF MINIMALLY PROCESSED AND FROZEN CAULIFLOWER

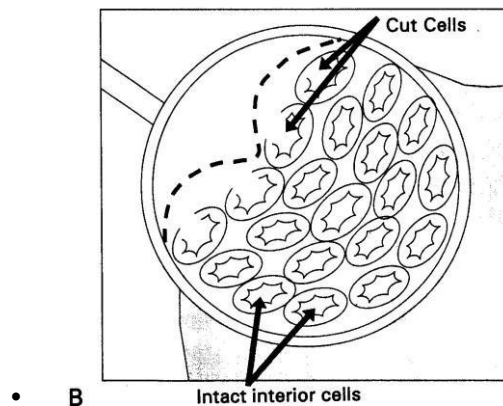
2.1 Minimal processing of cauliflower

Minimally processed cauliflower has been physically altered from its original form, but has remained in its fresh condition. Microbiological, sensory, and nutritional shelf life of minimal processed cauliflower should be at least 4-7 days but preferably even longer up to 21 days. Minimal processing cauliflower contain live tissues or those that have been only slightly modified from the fresh-condition and are fresh-like in character. The tissues do not exhibit the same physiological responses as the normal (raw) untreated live plant tissues. Respiration greatly increased in MP cauliflower.



Diagrams of intact and processed (cut) fruit or vegetable cell.

Intact cell is expected to be more resistant to oxidative browning and entrance of bacteria compared to the cut cell (MP).

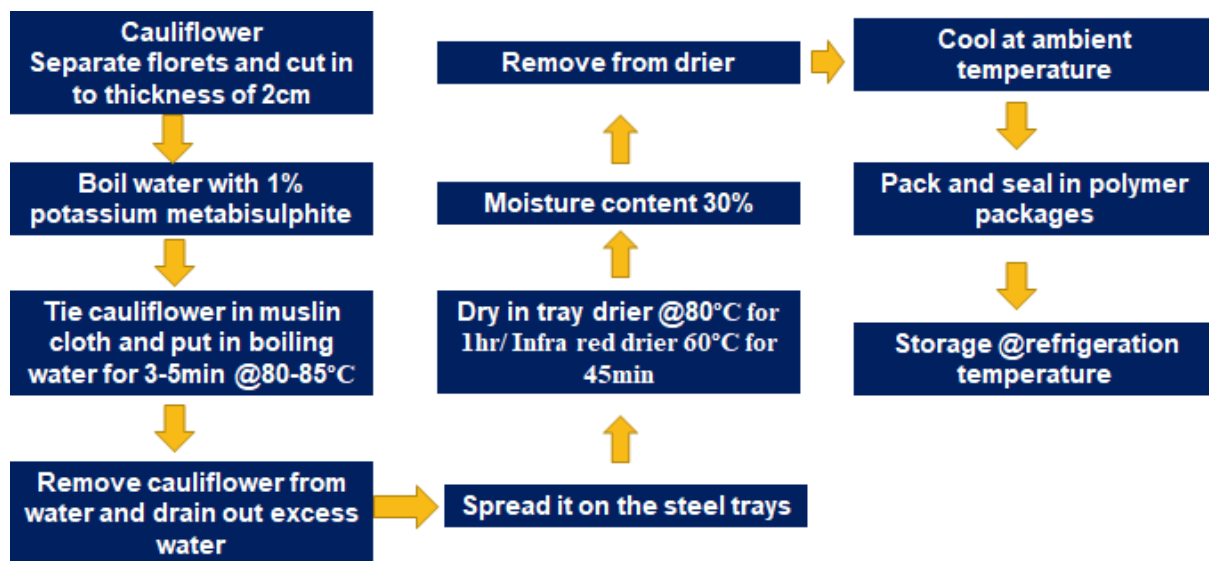


The presence of cut surface complicate the modeling of gas exchange in polymeric package.

2.2 Advantages of Minimal Processing

- HELPS TO RETAIN NUTRITIONAL VALUE
- FOOD TASTES FRESH
- CAUSES NO DAMAGE
- CAUSES NO CHANGES IN APPEARANCE

2.2.1 Minimally Processing of Cauliflower



2.2.2 Primary Processing of fruits and vegetables

Primary processing relates to conversion of raw agricultural cauliflower produce into a commodity that is fit for human consumption. It involves steps such as cleaning, grading, sorting, packing, etc. Secondary and tertiary processing industries usually deal with higher levels of processing where new or modified food products are manufactured. The primary processing of cauliflower can involve various processing methods as mentioned below: -

2.3 Operations carried out in Minimal Processing of Fruits and Vegetables

Most of the fresh produce requires the processing operations in order to produce the products. These are discussed below:

Sorting

Sorting is the preliminary step for segregating the acceptable and non-acceptable products. It is done to remove the physiological defects from the produce. Commonly, manual sorting results in high quality results in comparison to sorting by equipment in terms of peculiar minute defects.

Peeling

It is one of the common operations used for fruits and vegetables, such as carrots, potatoes, pumpkin, bottle and onion. Methods used for peeling directly influence the quality parameters of the final products. Peeling is usually carried out by hand or by abrasive peelers. Hand peeling provides the high quality product but often leads to expensive labour. However, abrasive peelers are also used for producing fine quality products, but they tend to damage the fresh products by causing scaring on the surface and edible portion can also be damaged. Engineering intervention has resulted in innovative mechanisms of peeling operations and automatic peelers for continuous operations of peeling are available for handling large volumes of vegetables in developed countries.

Cutting and Shredding

The unwanted parts of the plant based foods, such as seeds and stems need to be discarded before further processing. Therefore, trimming of the unwanted parts with eroded knives, cutters can pose a threat to the quality. The cutting tools should be cleaned and stored under good conditions. In addition, the overripe area or contaminated area should be discarded during initial sorting in order to prevent the growth of microbes and to avoid contamination of other infecting agents. Cutting and shredding must be performed with knives or blades that are as sharp as possible, these being made from stainless steel. Sharp blades are always better than blunt and dull blades. Blunt blades and knives impair the retention of quality because these rupture cells and release tissue fluid to a great extent. Mats and blades that are used in slicing operations can be disinfected with 1% hypochlorite solution. Cutting of vegetables should be preferably done under water. Because the internal liquid of injured cell is

removed by water flow, browning is markedly compared to any commercial cutting technique.

Washing

Washing is an important step for minimally processed fruits and vegetables and the following factors need to be considered. Proper washing of fresh cut fruits and vegetables is the utmost desired immediately after cutting. Washing is done in ice-cold water ($< 5^{\circ}\text{C}$). Washing the produce in flowing or air-bubbling water is preferable to simplify dipping it in water. Both the microbiological and the sensory qualities of washing water must be good and its temperature is low, preferably $< 5^{\circ}\text{C}$. The recommended quantity of water that should be used is 5-10 l/kg of product before peeling and/or cutting and 3 l/kg after peeling and/or cutting. Preservatives can be used in the washing water to reduce microbial numbers and retard enzymatic activity, thereby improving both the shelf-life and sensory quality of the product. This step removes the dirt and some microbes present on the surface of products. Usually chlorinated water is used for rinsing the peeled fruits and vegetables. Therefore, the contact time during washing, pH and temperature of the rinsing water play a key role for assuring the quality of products.

2.4 Factors affecting the washing of fresh-cut cauliflower

Contact time

The contact period needs to be considered for an effective operation. Generally, chilled water is required for rinsing the peels and cauliflower. Thus it is one way to cool the products before further processing and their packaging.

Temperature

Temperature needs to be controlled for avoiding the spoilage at preliminary step. It should be maintained at around 0°C .

Chlorination

Optimum concentration of chlorine needs to be used. The concentration of chlorine should be kept between 50 and 100 ppm. However, higher concentration of

chlorine can affect the quality of the peeled fruits and vegetables. Proper kits for chlorine testing should be used for controlling chlorine level in water.

pH

Optimum controlled pH is required for maintain the bactericidal activity of chlorinated water. If the pH rise above 7.5, the antibacterial effect would be vanished and spoilage of the products can occur due to microbial growth

Draining

Washing water should be gently removed from the product. Centrifugation seems to be the best method. It is important to choose the centrifugation time and rate carefully. CIPHET has developed a Basket Centrifuge which operates at 450 RPM and can remove the wash water efficiently from the fresh leafy vegetables etc.

Dipping in anti-browning agents

Browning inhibition: Browning is the main quality problem in pre-peeled or cut vegetables. What happens to the peeled potato, if you leave them open in air. You will find that after sometimes, the outer tissues start getting brown. This browning is basically a type of enzymatic browning, caused due to action of enzyme known as polyphenol oxidase (PPO). Oxidation of phenols in the presence of PPO causes these tissues to brown. Dipping the tissues in water or in salt water can reduce browning to some extent but cannot totally eliminate browning.

Frozen cauliflower

Freezing is a quick, convenient, and easy method of preserving foods in the home. Frozen foods are easy to serve because most of the preparation is done before freezing. Freezing preserves nutritive quality so that frozen foods resemble fresh foods. The five factors that are responsible for most of the quality losses of frozen foods are enzymes, air, microorganisms, large ice crystals, and evaporation of moisture.

Enzymes and Blanching

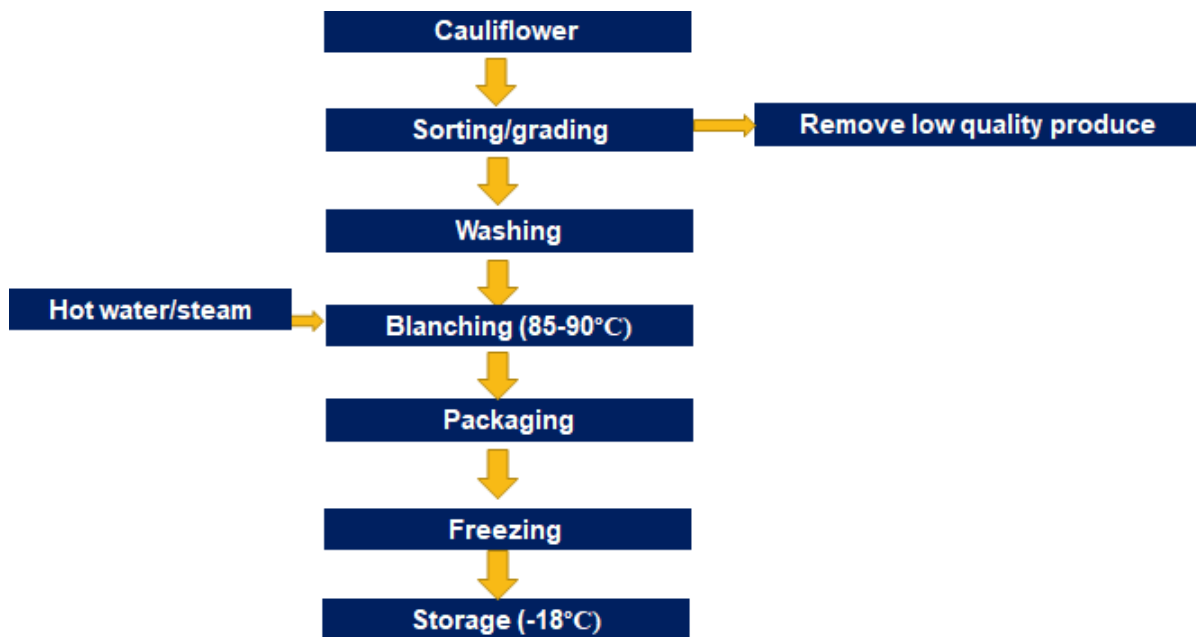
Enzymes are naturally occurring substances in plants that control the ripening process. Freezing only slows enzyme activity. Most frozen vegetables will lose quality in the freezer unless they have been blanched.

Purpose of blanching

- To improve flavor, color, texture, and nutrient retention
- To slow or stop the action of enzymes in the ripening process
- To cleanse the surface of dirt and organisms
- To brighten the color of green vegetables
- To wilt or soften vegetables, making it easier to fill containers

Ice Crystals—Freeze Quickly

Small ice crystals are desirable in frozen food to preserve its texture. Large ice crystals rupture food cells and cause a soft, mushy texture. Small crystals are formed when food is frozen quickly and kept at a constant storage temperature of 0°F or lower. Avoid adding more than 2 pounds of frozen food per square foot of freezer space because a larger volume of food will slow the freezing process and may raise the temperature of already frozen food.



FLOW CHART FOR FROZEN CAULIFLOWER

ADVANTAGES OF FROZEN CAULIFLOWER

- Good natural colour, flavour & nutritional value
- Maintains texture
- Extends shelf life
- Retards microorganism's growth.
- Slow down enzymatic and chemical reactions

CHAPTER 3

PACKAGING OF MINIMALLY PROCESSED AND FROZEN CAULIFLOWER

Packaging should protect the product from contamination and prevent it from spoilage, and at the same time it should:

- Extend shelf life
- Facilitate distribution and display
- Provide the consumer with greater ease of use and time-saving convenience
- Communicate with the consumer as a marketing tool

3.1 Good Packing Materials for cauliflower packaging

- Resistant to moisture and vapor
- Durable and leak proof
- Resistant to cracking and brittleness at low temperatures
- Resistant to oil, grease, and water
- Able to protect foods from absorption of off-flavors and odors
- Easy to seal
- Easy to label

Individually Quick Freezing or Tray Freezing

Foods such as cut green beans, peas, whole-kernel corn, and small mixed vegetables are suitable for freezing quickly before being packaged. This allows a partial amount of the food to be poured from containers without being thawed. After vegetables have been blanched, cooled, and drained, place them one layer deep on cookie sheets or shallow trays and freeze uncovered just until solid (4 to 6 hours), then quickly package and seal.

3.2 Packaging of cauliflower

It the last operation in the production of minimally processed vegetables. The most appropriate packaging method for pre-cut vegetable is modified-atmosphere packaging (MAP). The basic principle in MAP is to create a modified atmosphere either

passively or by using permeable packaging materials and by using a specified gas mixture with permeable packaging. The main purpose is to create an optimal gas balance inside the package, where the respiration activity of a product is as low as possible, but the levels of oxygen and carbon dioxide are not detrimental to the product.

In general, the aim is to have a gas composition of 2-5% CO₂, 2-5% O₂ and the rest nitrogen. However, Optimal O₂-CO₂ atmosphere cannot be maintained by use of most of the films, especially when the produce has a very high level of respiration. One solution to this problem is to make micro holes of a defined size and defined number in the matter to avoid anaerobiosis. Selection of the most suitable atmosphere depends on cultivars, stage of maturity, environmental and cultivation parameters. No one atmosphere is best for all reduce, specific recommendations and cautions must be determined for each crop over the range of storage temperature and periods.

Storage

Chilling is an important preservative hurdle, as is the control of humidity. Storage at 10°C or above allows most bacterial pathogens to grow rapidly on fresh cut vegetables. Storage temperature is also important when MAP or vacuum packaging is used. Toxin production by *Clostridium botulinum*, or growth of other pathogens such as *Listeria monocytogenes*, is possible at temperatures above 3°C because of increased oxygen consumption in the package. Processing, transport, display and intermediate storage should all be at the same low temperature (preferably 2-4°C) for produce not vulnerable to chilling injury. Changes in temperature should be avoided. Higher temperatures speed up spoilage and facilitate pathogen growth.

Fluctuating temperatures cause in-pack condensation which also accelerates spoilage. Temperature abuse is a widespread problem in the distribution chain, whether in storage, transportation, retail display and consumer handling. Where this is a significant problem, it may be necessary to restrict shelf-life, for example to 5-7 days at a temperature of 5-7°C, when psychrotrophic pathogens have insufficient time to multiply and produce toxin. If the shelf-life of vacuum or MAP products is greater than

10 days, and there is a risk that the storage temperature will be over 3°C, products should meet one or more of the following controlling factors:

- a minimum heat treatment such as 90°C for 10min
- a pH of 5 or less throughout the food
- a salt level of 3.5% (aqueous) throughout the food
- aw, water activity value of 0.97 or less throughout the food.
- any combination of heat and preservative factors which has been shown to prevent growth of toxin production by *C. botulinum*.

Post harvest storage

Cauliflower curds individually packed in high density polyethylene bags (20 µm) with perforation (6 holes/bag) can be stored up to 21 days at 0 °C and 90-95% RH with maximum retention of white color of curd, minimum spoilage, weight, and firmness loss and good sensory quality attributes. The use of cling wrap films should be avoided since it leads to accumulation of excessive moisture resulting in huge spoilage loss. Therefore, packing curds in individual HDPE bags, without washing and storage in cold stores is a commercially viable process for extending marketability of cauliflower.

Controlled Atmosphere (CA) Storage and Modified Atmosphere Packaging (MAP)

CA storage is not recommended for cauliflower storage as it produces soft curds and off-odors. A maximum level of 10% CO₂ can be used at 0 °C; at higher temperatures, even 5% CO₂ causes severe injuries. The GLS content, however, increases during these conditions of storage.

3.3 Wrapping styles for cauliflower packaging

Flow wrapping

Flow wrapping is a horizontal-motion process in which product of any shape is wrapped in clear or printed polypropylene film. The end result is a flexible package with a non-lap type seal on the bottom and crimped end seals.

Shrink wrapping

Shrink wrap, also shrink film, is a material made up of polymer plastic film. When heat is applied, it shrinks tightly over whatever it is covering. Heat can be applied with a handheld heat gun (electric or gas), or the product and film can pass through a heat tunnel on a conveyor.

Conclusion

The market of minimally processed foods has grown rapidly in recent years due to the health benefits and convenience associated with these foods. Its growth has increased the awareness regarding microbiological and physiological aspects associated with the quality. The consumerism tendency depends on multi-factors as nutritional value, simplicity, safety, and convenience. All these characteristics must be considered in minimal processing. There are emerging technologies and opportunities that will have far reaching impact on the market place. Advanced packaging systems and edible films, as well as more permeable plastic films which better match with the respiration of fruits and vegetables, are particularly active areas for development. Issues such as sustainability in packaging and the impact that packaging has on current food safety issues are already providing both tremendous challenges and opportunities.

Much research is still needed to develop minimally processed fruits and vegetable products that have a high sensory quality, microbiological safety and nutritional value. Products intended for retailing are in particular need of further development. It seems that it is possible to achieve a shelf life of 7-8 d at refrigeration temperatures (5°C), but for some markets this is not enough: a shelf life of 2-3 weeks is sometimes necessary. More information about the growth of pathogenic bacteria and the occurrence of nutritional changes in minimally processed fruits and vegetables with long shelf life is needed. The challenge will be how to incorporate all of the desired requirements into a better and shelf-stable minimal processing solution for fresh-cut fruits and vegetables.

CHAPTER 4

FSSAI STANDARDS AND FOOD SAFETY

4.1 FSSAI STANDARDS FOR MINIMALLY PROCESSED CAULIFLOWER

4.2.1 Fresh vegetables, (including mushrooms and fungi, roots and tubers, pulses and legumes, and aloe vera), seaweeds and nuts and seeds

4.2.1.3 Peeled, cut or shredded minimally processed vegetables [(including mushrooms and fungi, roots and tubers, fresh pulses and legumes, and aloe vera) sea weeds, nuts and seeds

Food category System	Food Category Name	Food Additive	INS No	Recommended Maximum Level	Note
4.2.1.3	Peeled, cut or shredded	Lauric arginate ethyl ester	243	200 mg/kg	
	Minimally processed	PHOSPHATES		5,600 mg/kg	33,76
	vegetables	Sodium Ascorbate	301	GMP	
	[(including mushrooms and fungi, roots and tubers, fresh	SULFITES		50 mg/kg	44,76,136
	pulses and legumes, and	Calcium chloride	509	350 mg/kg	
	aloe vera) sea	Calcium lactate	327		
	weeds, nuts and seeds)	Calcium Gluconate	578		

		Calcium carbonate	170(i)		
		Citric acid	330	GMP	
		Ascorbic acid	300	GMP	
		Calcium ascorbate	302	GMP	
		Potassium carbonate	501	GMP	

FSSAI STANDARDS FOR FROZEN CAULIFLOWER

2.3.38.B FROZEN CAULIFLOWER

1. Frozen cauliflower shall be prepared from fresh, clean, sound heads of the cauliflower plant of the species *Brassica oleracea* L. var. *botrytis* L., from which heads may be trimmed and separated into parts, are washed and sufficiently blanched to ensure inactivation of enzymes and stability of colour and flavour and shall be stored at -18°C or below. The product may contain salt, spices and herbs, sugars, edible fats and oils, sauces, milk solids and any other ingredients suitable to the product whose standards are prescribed under Food

Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011.

2. The product shall be of reasonably uniform white to dark cream colour which may be slightly dull and have a tinge of green, yellow or pink over the flower surface. The stem or branch portions may be light green or have a tinge of blue. It shall be free from foreign flavours or odours, other than those imparted by any added ingredients. The product shall be clean, free from sand, grit and other foreign material and shall test negative for peroxidase. It shall not contain any added colour.

3. The product may be presented in one of the following styles and shall be labelled accordingly:-

(i) Whole: the whole, intact head, which is trimmed at the base and which may have attached small, tender, modified leaves.

(ii) Split: the whole head, cut vertically into two or more sections.

(iii) Florets: segments of the head, which may have a portion of the secondary stem attached. Small, tender modified leaves may be present or attached to the units.

(iv) Others: any other presentation of the product is permitted provided that it is sufficiently distinctive from other forms of presentation laid down in this standard and is adequately described on the label to avoid confusing or misleading the consumer.

4. The product shall not exceed the tolerance for visual defects as given in Table below. The maximum number of defects shall not exceed the tolerance given in column (3) (4) and (5) of the following Tables. The combined total of all categories shall not exceed the limits indicated in S.No.9 of Table 1 for whole styles and S.No 11 of table 2 for split, florets and other styles. The standard sample size shall be 500gm.

FOOD ADDITIVES FOR FROZEN CAULIFLOWER

S.No	Defects	Total allowable numbers of defects for each Category (Maximum)		
Whole Style		Category 1 (Minor)	Category 2 (Major)	Category 3 (Serious)
1	Discolouration (each unit)- Light and Dark			
2	Blemished (each head)- Minor, Major and Serious			
3	Mechanical Damaged (each head)	10	6	4
4	Fibrous (each unit)- Fibrous Major and Fibrous Serious			

5	Poorly trimmed (each head)	
6	leaves (each 2cm ²)	
7	Not compact (Each area or combined area of 12 cm ²)	
8	Combined total Allowable number of defects(Maximum)	10

S.No	Defects	Total allowable numbers of defects for each Category (Maximum)		
Split, Florets and Other Styles		Category 1 (Minor)	Category 2 (Major)	Category 3 (Serious)
1	Discolouration(each unit)-Light and Dark	25	16	4
2	Blemished (each unit)- Minor, Major and Serious			
3	Mechanical Damaged (each unit)			
4	Fibrous (each unit)- Fibrous Major and Fibrous Serious			
5	Poorly trimmed (each unit)			
6	Leaves (each 2cm ²)			

7	Fragments (each 3per cent. m/m)	
8	Not compact (Each area or combined area of 12 cm ²)	
9	Loose stem (each piece)	
10	Combined total Allowable number of defects(Maximum)	25

Explanation:- for the purpose of this sub-regulation,-

- (i) **Discolouration.- grey, brown, green or similar discolouration confined essentially to** the flower surface of the unit and which materially detracts from the appearance of the product. Branches or stems with a bluish or greenish tinge are not be considered as discoloured.
 - (a) **Light.- the discolouration disappears almost entirely upon cooking.**
 - (b) **Dark.- the discolouration does not disappear upon cooking.**
- (ii) **Blemished.-A unit affected by pathological or insect injury, and which may extend into the cauliflower.**
 - (a) **Minor.-The appearance of the unit is only slightly affected.**
 - (b) **Major.-The appearance of the unit is materially affected.**
 - (c) **Serious.-The appearance of the units is objectionably affected to such an extent** that it would customarily be discarded under normal culinary preparation.
- (iii) **Mechanically Damaged.-**
 - (a) **Major (for split and floret styles).-A unit in which more than 50 percent of the** curd (head or combine florets) has been mechanically damaged or is missing.
 - (b) **Major (for whole Styles).-A unit in which more than 25 per cent. of the** curd(head or combine florets) has been mechanically damaged or is missing.
- (iv) **Major Fibrous.-A unit which possess tough fibres that are quite noticeable and** materially affect the eating quality.

- (v) **Serious Fibrous.**-A unit which possesses tough fibres that are objectionable and of such nature that it would be customarily discarded.
- (vi) **Poorly Trimmed.**-A unit which had deep-knife gouges or a ragged appearance.
- (vii) **Leaves.**-Coarse green leaves or parts thereof whether or not attached to the unit.
- (viii) **Fragments.**-Portions of the florets 5 mm or less across the greatest dimension.
- (ix) **Not Compact.**-A unit in which the florets are spreading, or the flower head has 'ricey' appearance or the flower head is very soft or musty.
- (x) **Loose stem.**- Each piece of stem exceeding 2.5 cm in length detached from a cauliflower unit.

4.2 Food Safety

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

SANITARY AND HYGIENIC REQUIREMENTS FOR FOOD MANUFACTURER/PROCESSOR/HANDLER

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

1. The premises shall be located in a sanitary place and free from filthy surroundings and shall maintain overall hygienic environment. All new units shall set up away from environmentally polluted areas.
2. The premises to conduct food business for manufacturing should have adequate space for manufacturing and storage to maintain overall hygienic environment.
3. The premises shall be clean, adequately lighted and ventilated and sufficient free space for movement.

4. Floors, Ceilings and walls must be maintained in a sound condition. They should be smooth and easy to clean with no flaking paint or plaster.
5. The floor and skirted walls shall be washed as per requirement with an effective disinfectant the premises shall be kept free from all insects. No spraying shall be done during the conduct of business, but instead fly swats/ flaps should be used to kill spray flies getting into the premises. Windows, doors and other openings shall be fitted with net or screen, as appropriate to make the premise insect free The water used in the manufacturing shall be potable and if required chemical and bacteriological examination of the water shall be done at regular intervals at any recognized laboratory.
6. Continuous supply of potable water shall be ensured in the premises. In case of intermittent water supply, adequate storage arrangement for water used in food or washing shall be made.
7. Equipment and machinery when employed shall be of such design which will permit easy cleaning. Arrangements for cleaning of containers, tables, working parts of machinery, etc. shall be provided.
8. No vessel, container or other equipment, the use of which is likely to cause metallic contamination injurious to health shall be employed in the preparation, packing or storage of food. (Copper or brass vessels shall have proper lining).
9. All equipments shall be kept clean, washed, dried and stacked at the close of business to ensure freedom from growth of mould/ fungi and infestation.
10. All equipments shall be placed well away from the walls to allow proper inspection.
11. There should be efficient drainage system and there shall be adequate provisions for disposal of refuse.
12. The workers working in processing and preparation shall use clean aprons, hand gloves, and head wears.

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

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

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

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

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

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

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

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

4.3 LABELLING

Labeling Requirements

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

Applicability of Food Labelling Regulations

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

General Labelling Requirements

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

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

Nutritional Information

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

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

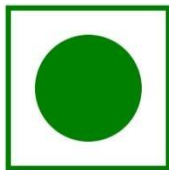
Veg or Non-Veg Symbol

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



Non-Veg Symbol

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



Veg Symbol

Information Relating to Food Additives, Colours and Flavours

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

Name and Complete Address of the Manufacturer

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

Net Quantity

All packaged food must carry the net 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 or 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.



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