PM Formalization of

Micro Food Processing Enterprises (PMFME) Scheme

HANDBOOK

OF

SWEET CORN

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TABLE OF CONTENTS

PAGE NO

CHAPTER 4 : PACKAGING

CHAPTER 5 : FSSAI REGULATIONS

CHAPTER 1

INTRODUCTION

1.1.CEREAL GRAINS

Cereal grains (or simply grains) are small, hard and edible dry seeds that grow on grass-like plants called cereals. They are a staple food in most countries, and provide more food energy worldwide than any other food group, by far. Grains have played a major role in human history, and grain agriculture is one of the main advancements that fueled the development of civilization. They are eaten by humans, and also used to feed and fatten up livestock. Then grains can be processed into various different food products.

Cereals form a major portion of human diet and are an important source of starch and other dietary carbohydrates (dietary fibre), which play an important role in the energy requirement and nutrient intake of human. The wide variety of wheat flours generally available includes whole wheat, or graham, flour, made from the entire wheat kernel and often unbleached; gluten flour, a starch-free, high-protein, whole wheat flour; all-purpose flour, refined (separated from bran and germ), bleached or unbleached, and suitable for any recipe not requiring a special flour; cake flour, refined and bleached, with very fine texture; self-rising flour, refined and bleached, with added leavening and salt; and enriched flour, refined and bleached, with added nutrients.

Flours are also made from other starchy plant materials including barley, buckwheat, chickpeas, lima beans, oats, peanuts, potatoes, soybeans, rice, and rye.

A whole grain consists of 3 main parts:

- Bran: The hard, outer layer of the grain. It contains fibre, minerals and antioxidants.
- Germ: The nutrient-rich core that contains carbs, fats, proteins, vitamins, minerals, antioxidants and various phytonutrients. The germ is the embryo of the plant, the part that gives rise to a new plant.
- Endosperm: The biggest part of the grain contains mostly carbs (in the form of starch) and protein.
- A refined grain has had the bran and germ removed, leaving just the endosperm

Maize (corn) is the second largest crop in the world, and the largest in the United States. Popcorn is one of the oldest snack foods, it was discovered by Native Americans and became a popular snack during the Depression. The corn kernel itself (where popcorn comes from) is considered a grain. To complicate things a little more, many grains including popcorn are considered to be a fruit. This is because they come from the seed or flower part of the plant.

Popcorn officially crossed into Western culture at the first Thanksgiving celebration. The Indians' methods for popping corn varied from tribe to tribe. They probably discovered how to pop popcorn by accident because the hard kernel doesn't give any hint of the potential treat inside. The earliest poppers of corn may have thrown it into the fire and eaten the kernels when they popped and flew out of the flames. Our only historical evidence of early but more sophisticated popping methods is from the Incas whose ruins contain specially shaped clay pots with kernels of popped corn still inside them. The Incas apparently heated sand and placed it in these pots, then placed the corn on the sand. The pot was covered, and heat from the sand popped the kernels. The heavier sand stayed at the bottom of the pot, and the popped kernels rose above it where they could be reached.

1.2 TYPES OF CEREAL GRAINS

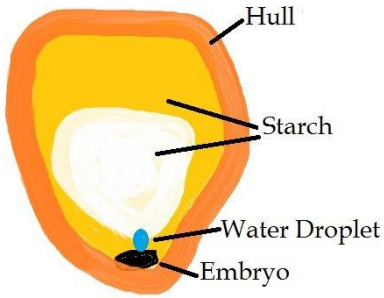
The cereals most commonly cultivated are wheat, rice, rye, Oats, wheat, barley, corn (maize), and sorghum.

Image	Name	Description
	**Rice (*Oryza sativa*).**	Rice is an excellent source of calories because of its starch content. It contains 75-80% of starch, 7% of protein, 0.4-0.8% of lipids and 12% of water. Rice oats protein is of highly digestible quality and contains lysine 4.1mg/100g of protein higher than wheat.
	**Barley**.	It is highly nutritious and important for malting. Mostly used as a breakfast cereal with oat, it is also used as a feed for animals. It is mostly grown on land which is not capable of growing wheat
	**Sorghum**	Highly nutritious and used as a feed for livestock.
	**Millet**	Mostly grown Asia and Africa, wheat porridge is popular in China, Russia and Germany. It can also be used to make alcoholic beverages, as an animal feed and bird feed.
	**Oats**	A staple cereal in Scotland, they are highly nutritious and used as breakfast cereals in more than half of the world. Due to high content of fibre it is popular to reduce weight and for lowering blood sugar level.

	**Rye**	The cereal grain of cold climates, used for making beer, breads, whiskeys, vodka and also use as animal fodder.
	**Maize**	Corn is a staple cereal in continents like South America and Africa, and used as an animal feed worldwide. Cornflakes are also a popular cereal globally.
	**Wheat**	Wheat is a major cereal crop and one of the oldest domesticated grains. In modern times, wheat is used to produce meal, breakfast cereals, and oats for bakery products. It can be cultivated in a wide range of soils but thrives in temperate climates.

1.3 SWEET CORN

Corn kernels are the fruits of corn (called maize in many countries). Maize is a grain, and the kernels are used in cooking as a vegetable or a source of starch. The kernel comprise endosperm, germ, pericarp, and tip cap. One ear of corn contains roughly 800 kernels in 16 rows.



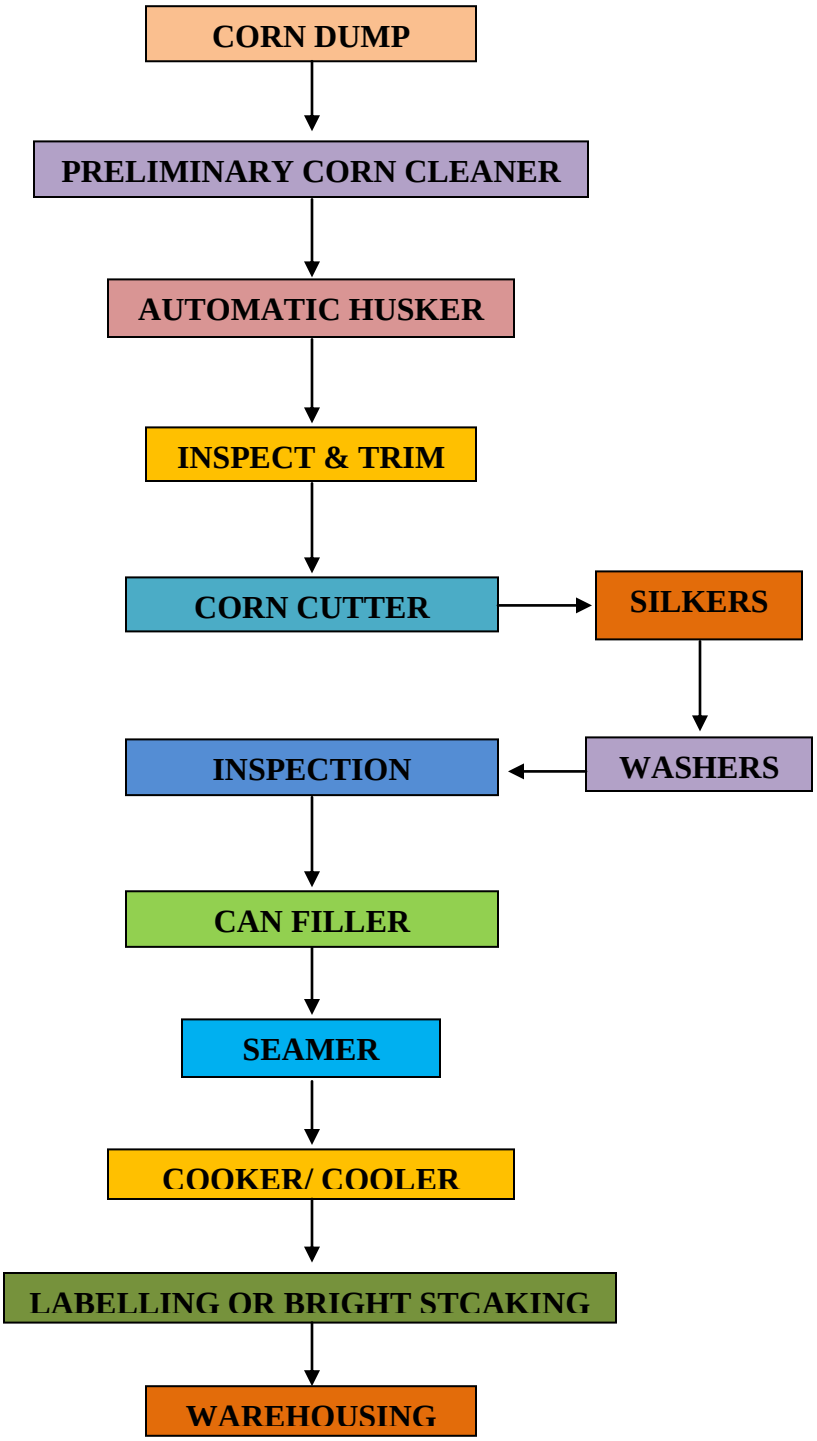
The outer layer of the kernel comprised of pericarp, a component of seed coat. The thickness of the layer determines the kernel skin level of tenderness. This feature is important for the estimation of kernel quality for processing. The thickness of pericarp in sweet corn ranges from 25-30µm.

1.4 NUTRITIONAL VALUE OF SWEET CORN AS PER USFDA

Components	Values
Calories	90
Calories from Fat	20
Total Fat	2.5g
Potassium	250 mg
Total Carbo-hydrate	18g
Dietary Fiber	2g
Sugars	5g
Protein	4g

CHAPTER 2

2.1 SWEET CORN PROCESSING



2.1.1 HARVESTING :

Harvesting of corn is done after proper maturity and the entire ear with the husk on is taken to the canning plant by truck. Before dumping the corn to the dump pad it is properly weighed. Delay should be avoided in processing of corn otherwise it may affect the sweetness of corn.

2.1.2 CLEANING :

A conveyor in the dump pad moves the corn to the preliminary corn cleaner where loose husks and stalks are removed by high velocity air.

2.1.3 HUSKING :

Husk removing of corn is done with the help of husking machine. There are two types of husking machine one is automatic butting and nonbutting huskers. Non butting husker are mostly used due to less generation of waste. Husking machine preferred over manual removal of husk because they do little injury to the corn.

2.1.4 SILKING :

Silking is performed as a separate operation by running the corn through a special machine that rolls the ear rapidly between a pair of rollers and at the same time brushes it with fibre brushes as the ear advances. Sprays of water are introduced at the same time, which wash away the silk and clean the ears.

2.1.5 INSPECTION :

When the corn is properly washed and moving toward the cutter then it is inspected on a moving belt. The ears which are not suitable for canning processing are removed.

2.1.6 CUTTING:

Cutting is done with the help of knives, which should be sharp enough to avoid group pulling of kernel. The depth of cutting should be deep to take out most of the kernel, yet not cut into the cob.

2.1.7 WASHING OF CUT CORN :

Washing of corn is an important stage to remove microbial load and preventing the product from spoilage. Efficient types of washers are made especially for this purpose. If some flotation type of washer is used, this should be followed with a spray wash using fresh water at 82–93°C (180–200 °F), which not only aids in the reduction of contamination, but also removes the chill from the corn.

2.1.8 FILLING AND BRINING :

In order to remove air from the cut kernels it is helpful to blanch the kernels in hot water or exhaust the filled cans before closure. The inspected kernels are then transferred to filling machines, similar to or identical with the ordinary pea filler, filled into cans, and brined with boiling hot water or a weak salt brine. When salt is used, the amount may be as little as 0.5%, but the average is approximately 2%. The brine should be added at or near the boiling temperature to accomplish an initial temperature of from 60 to 71°C (140–160 °F) in the can.

2.1.9 SEAMING:

Seaming is done to pack the mouth of can an then send for next process.

2.1.10 RETORT :

The time and temperature of retort varies as per the size of the can, larger will the can, more time will required for the retort process. For example a can with 170g fill required at least 42 minutes at 116ºC, 27 minutes at 118ºC and 18 minutes at 121ºC where a can with 340g fill required 52 minutes at 116ºC, 36 minutes at 118 ºC and 26 minutes at 121 ºC.

2.1.11 COOLING :

After retorting the can are allow to cooled under pressure and when the temperature decreases to 38ºC then only it can stacked.

CHAPTER 3

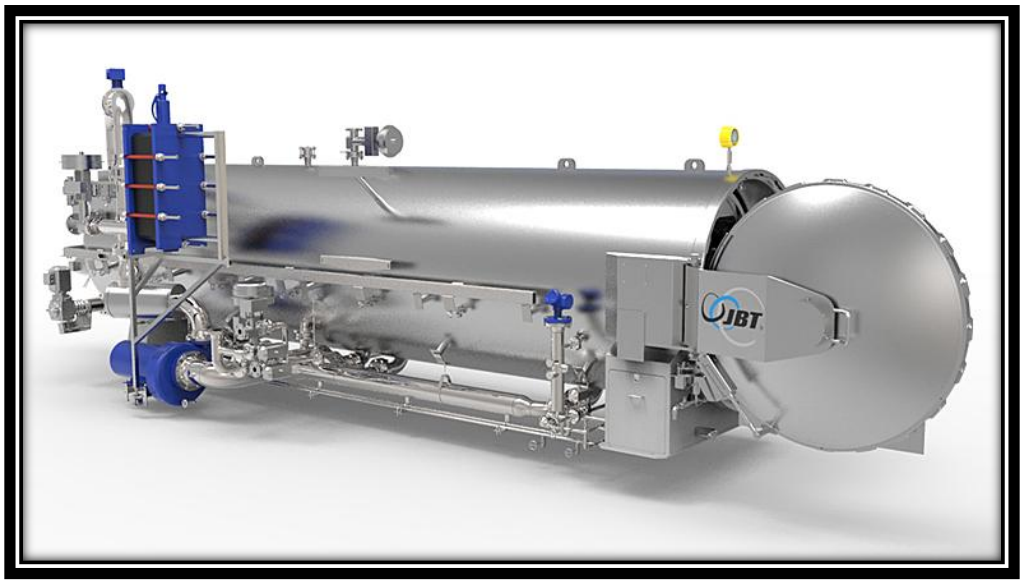
EQUIPMENT REQUIRED FOR SWEET CORN PROCESSING

3.1 HUSKING MACHINE : Corn husking machine is used to remove the husk of the corn.

3.2 DE SILKING MACHINE : This machine is used for the removal for silk from the corn.

3.3 CORN KERNEL REMOVER MACHINE : Removing of kernel from cob is an important steps in processing which is done with help of kernel remover machine. Kernel is separated in well manner to avoid any kind group pulling.

3.4 RETORT : Retort is used for sterilization of can so that microbial load can be reduced.



3.5 GRAVITY SEPARATOR : Gravity separator machine may be used to separate any type of dry bulk particles that are similar in size and shape but differs in weight. Gravity separator are suitable for processing of the seeds of corn, Wheat, rice, soybean, sorghum, various vegetables and other agricultural and sideline products.

3.6 FOOD GRADE CONVEYOR: These are conveyors with food grade belt to maintain food safety standards set by monitoring authorities.

3.6 OTHER MATERIAL AND HYGIENE EQUIPMENT : The are simply used to hold and transfer the given material efficiently.

3.6 POWER DISTRIBUTION EQUIPMENTS : They are used to safely receive and distribute power.

CHAPTER 4

4.0 PACKAGING :

Packaging is an important part of food manufacturing process. It protect the food products from physical ,chemical, biological damages. Without packaging, food handling would be a messy, inefficient and costly exercise and modern consumer marketing would be virtually impossible. Thus food packaging lies at the very heart of the modern food industry.

Packaging Institute International defined packaging as the enclosure of products, items or packages in a wrapped pouch, bag, box, cup, tray, can, tube, bottle or other container form to perform one or more of the following functions: containment, protection, preservation, communication, utility and performance. If the device or container performed one or more of these functions, it was considered a package.

4.1 NEED OF PACKAGING :

Packaging performs a series functions:

4.1.1 CONTAINMENT : The containment function of packaging makes a huge contribution to protecting the environment from the myriad of products that are moved from one place to another on numerous occasions each day in any modern society. Faulty packaging (or under-packaging) could result in major pollution of the environment.

4.1.2 PROTECTION : the primary function of the package: to protect its contents from outside environmental influences such as water, water vapor, gases, odors, microorganisms, dust, shocks, vibrations and compressive forces.

4.1.3 CONVENIENCE : Products designed to increase convenience include ready to cook or ready to eat foods which can be reheated in a very short time, preferably without removing the primary package. Thus, packaging helps in convenience of consumer. Convenient packages promote sales.

4.1.4 COMMUNICATION : Packaging contains a lot of information such name of its manufacturer, product name, terms and uses, date of manufacturing, best before. nutritional information thus helping the consumer to be more informed.

4.2 TYPES OF PACKAGING :

4.2.1 PRIMARY PACKAGING :

- Primary package are those package which directly came into contact with food products. It provides first or initial layer of protection to the food products.
- Examples - Metal cans, tea bag, paperboard cartons, glass bottles and plastic pouches.

4.2.2 SECONDARY PACKAGE :

- Secondary package are those package which surrounds or contains the primary package.
- It further used to group primary packages together.
- Act as carriers and many a times also used for the display of primary package.
- Examples are Corrugated case, Boxes.

4.2.3 TERTIARY PACKAGE :

- It contains number of secondary package together.
- Mainly used for bulk handling of food products.
- Example : stretch-wrapped pallet.

4.2.4 QUATERNARY PACKAGE :

- Quaternary package is mainly used for handling the tertiary packages.
- It generally includes a metal container which can be transferred to or from ships, trains.

4.3 PACKAGING OF SWEET CORN PRODUCTS :

Packaging of sweet corn bean and its products are mainly done to protect the food products from outside environment especially after the completion of process so that products can retain flavor, aroma, freshness for a longer period of time. Packaging is also done to increase their shelf life. Sweet corn bean products can be packed in wide range material which includes LDPE, PET, glass, aluminum etc.

4.3.1 LDPE :

Low-density polyethylene is heat sealable, inert, odour free and shrinks when heated. It act as a barrier to moisture and has high gas permeability, sensitivity to oils and poor odour resistance. It is less expensive, therefore widely used. One of the great attributes of LDPE is its ability to be fusion welded to itself to give good, tough, liquid-tight seals.

4.3.2 PET :

PET can be made into film by blowing or casting. It can be blow moulded, injection moulded, foamed, extrusion coated on paperboard and extruded as sheet for thermoforming. Melting point of PET is higher than PP which is around 260°C and due to the manufacturing conditions does not shrink below 180°C. Thus PET is ideal for high-temperature applications. PET is also flexible to low temperature (-100°C). It also act as good barrier of oxygen and water vapour.

4.3.3 POLYPROPYLENE :

Polypropylene films have better clarity than polyethylene and enjoy superior machinability due to stiffness. Lack of good salability has been a problem; however, PVDC and vinyl coating have been used to overcome this problem. Some varieties of PP have been specially developed for twist-wrap applications as they have the ability to lock in position after twisting.

4.3.4 GLASS :

Now a day glass container has been also used for packaging. It has following advantages:

- act as strong barrier to moisture and gases.
- Prevent unwanted odors and microbial growth.
- do not react with food products.

- suitable for heat processing when hermetically sealed
- glass are re-useable and recyclable
- they are transparent to display the contents
- they are rigid, to allow stacking without container damage.

The disadvantages of glass include:

- glass have high weight which increases the transportation cost.
- very much fragile and low resistance to thermal shock as compare to other materials.
- potentially serious hazards from glass splinters or fragments .

4.3.5 ALUMINIUM:

Aluminium is used for packaging due its highly malleable properties: can be easily converted to thin sheets and folded, rolled or packed. Aluminium foil acts as a total barrier to light and oxygen odours and flavors, moistness, and germs, and so it is used broadly in food and pharmaceutical packaging, including long-life packs.

4.3.6 LAMINATE :

The laminates can be formed, filled, gas flushed and sealed on a single machine from reel stock. Gas flushing is achieved by saturating the powder with inert gas. The main advantages associated with laminates are lower material cost and lighter material weight. The disadvantages are that laminates do not have the mechanical strength and durability of rigid containers, and there can be difficulty in obtaining a satisfactory heat seal because of contamination of the heat seal area by powder during filling at high speed.

4.4 SOME RECENT DEVELOPMENT IN PACKAGING :

4.4.1 ASPECTIC PACKAGING

Aseptic packaging is the filling of sterile containers with a commercially sterile product under aseptic conditions, and then sealing the containers so that reinfection is prevented; that is, so that they are hermetically sealed. Application of aseptic packaging involves: packaging of pre-sterilized and sterile product and packaging of a non-sterile product to avoid infection by microorganisms.

The major reasons for the use of aseptic packaging are : to take advantage of high temperature-short time (HTST) sterilization processes, to enable containers to be used that are unsuitable for in-package sterilization and to extend the shelf life of products at normal temperatures.

4.4.2. ACTIVE AND INTELLIGENT PACKAGING

Active packaging is defined as packaging in which subsidiary constituents have been deliberately included in or on either the packaging material or the package headspace to enhance the performance of the package system.

Intelligent packaging is defined as packaging that contains an external or internal indicator to provide information about the history of the package and/or the quality of the food. Sachets and pads are the most widely used forms of active packaging and the various functions which they perform are discussed in the following:

- Oxygen absorber
- Carbon dioxide absorber or emitter
- Ethylene absorber
- Ethanol emitter
- Moisture absorber

4.4.3 MODIFIED ATMOSPHERE PACKAGING

MAP can be defined as packaging of food items where atmosphere inside the packet has been modified to increase the shelf life of food products. It involves active modification or passive modification. In active modification air is displaced with a controlled, desired mixture of gases, and the process is called as gas flushing. Passive modification occurs due to respiration and the metabolism of microorganisms associated with the food. The package structure normally incorporates a polymeric film, and so the permeation of gases through the film also influences the composition of the atmosphere that develops.

4.5 LABELING

Labeling performs the communication function of packaging, informing the consumer about nutritional content, net weight, product use and so on. Labeling acts as a silent salesman through distinctive branding, as well as facilitating identification at check-outs through the Universal Product Code (UPC).

There various types of labeling which are as follows:

4.5.1 GLUED-ON LABELS : These are the simplest type and consist of sheet material (typically paper), which has been printed and cut to size. They are attached to the package with adhesive, which is applied either at the time of application, or at the time of manufacture, in which case the adhesive is activated with moisture immediately prior to application.

4.5.2 SELF-ADHESIVE (PRESSURE-SENSITIVE) LABELS : These can be made from paper, plastic or aluminum foil laminated to paper or plastic, and can be produced to adhere to a wide range of materials.

4.5.3 IN-MOLD LABELS : It offers better resistance to heat, moisture and chemical than those labels made from paper. There are also recycling advantages with film labels. IML materials must be able to withstand the container manufacturing process. The heat generated during blow molding presents a challenge to most inks because pigments can change.

4.5.4 SLEEVE LABELS : A wide range of containers can be sleeve labeled including glass bottles, plastic bottles and metal cans. Sleeve labels shrink into or stretch around contours, penetrate variable geometries and conform to irregular features.

4.5.5 HOLOGRAPHIC LABELS : Holographic labels that incorporate a hologram have large application in food packaging for both marketing and security reasons, specifically in the areas of anticounterfeiting (authentication) and brand protection. Surface relief and volume are the most common type of hologram. Surface relief holograms exhibit a characteristic rainbow-colored pattern or image. Volume, or reflection, holograms have a very different appearance to surface relief holograms and are generally used for authentication.

4.6 QUALITY CONSIDERATIONS DURING PACKING

Quality control of packed products is the last time the product is checked before reaching the customer.

Documented checking of the packages entails:

- Weight of the package
- Weight of the product
- Arrangement of the product
- Defects; and Moisture content.

The surrounding area is also checked:

- Cleanliness of the handling equipment during processing
- Calibration of the scales (automatic or manual);
- Writing on the packages;
- Satisfactory working of the metal detector (installed on every retail packing line);
- Repackaging installations and marking; and

Qualification for international standards such as ISO and HACCP

CHAPTER 5

5.1 FSSAI REGULATIONS

Thermally Processed Vegetables (Canned, Bottled/Flexible pack / Aseptically Packed) means the product obtained from fresh, dehydrated or frozen vegetables either singly or in combination with other vegetables, peeled or un-peeled, with or without the addition of water, common salt and nutritive sweeteners, spices and condiments or any other ingredients suitable to the product, packed with any suitable packing medium appropriate to the product processed by heat, in an appropriate manner, before or after being sealed in a container so as to prevent spoilage. The packing medium along with its strength shall be declared on the label. The product may be prepared in any suitable style appropriate to the product. The product may contain food additives permitted in these Regulations and Appendices. The product shall conform to the microbiological requirements given in Appendix B. The name of the vegetables used in the product and prepared in any style shall be declared on the label along with the range of percentage of each vegetable used in the product. Drained weight of vegetables shall be not less than the weight given below:—

(i) Liquid Pack

(a) Mushroom	50.0 percent of net weight of contents
(b) Green beans, carrots, peas, sweet corn/ baby corn	50.0 percent of net weight of contents
(c) Mushroom Packed in sauce	25.0 percent of net weight of contents
(d) Other Vegetables	50.0 percent of net weight of contents

(ii) Solid Pack 70.0 percent of net weight of contents

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

5.2 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.