Post Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products

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Lecture 59
FSSAI Regulations & FSMS Guidelines for Fruits, Vegetables, Spices and Plantation Crops

This lecture discussed various aspects of FSSAI regulations and FSMS guidelines for fruits, vegetables, spices and plantation crops.

The concepts covered in this lecture are FSSAI regulations and product standards i.e. major products from fruits and vegetables, spices, etc. Other than that, spice adulteration, food safety management system and HACCP implementation and CCPs were discussed.

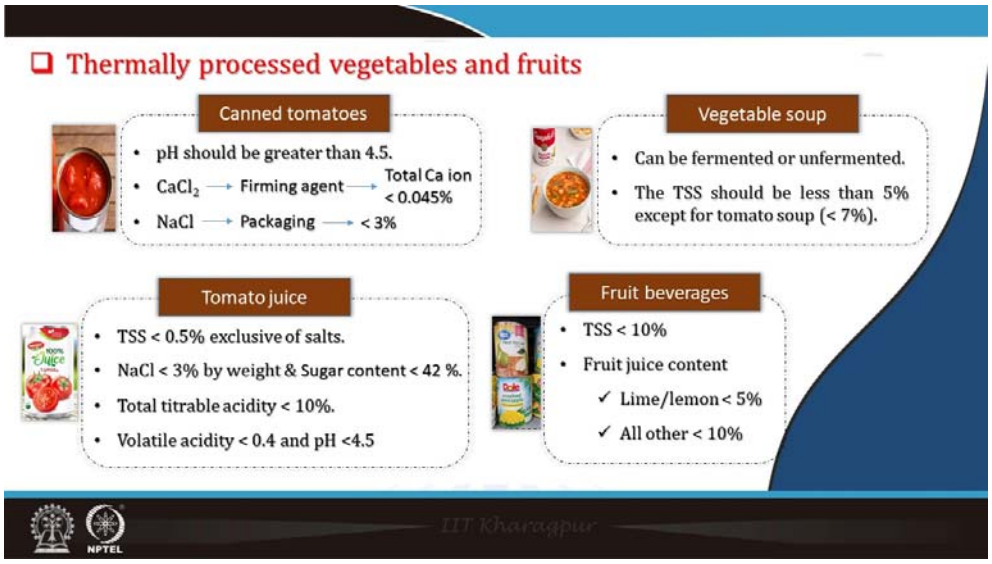
Criteria for defining food safety standards in FSSAI

Food Safety and Standard Authority of India (FSSAI) has been constituted has the authority to decide various rules, regulations, quality standards, safety standards, etc. for all food products and the FSSAI guidelines or regulations are mandatory in nature. So, every food business operator or food manufacturer has to follow the FSSAI guidelines. FSSAI has certain norms for defining the safety and quality standards. There are various kinds of descriptions of each quality parameters, which are taken into consideration in the FSSAI regulations.

The criteria for the safety standards or quality standards include detailed description for each quality parameter of the same type of products. The product was described for having a detailed know-how for food processors. The quality factors which describes the quality related to packing, sensory, nutritional, etc. are mentioned detail related to the product. The labeling includes tag, brand, mark, pictorial or other descriptive matters of the products relating to packaging and its labeling and then finally, limitations of quality attributes values, this includes the range of the quality attribute values for the products and these are decided on the basis of a very thorough scientific considerations and discussions by the committees.

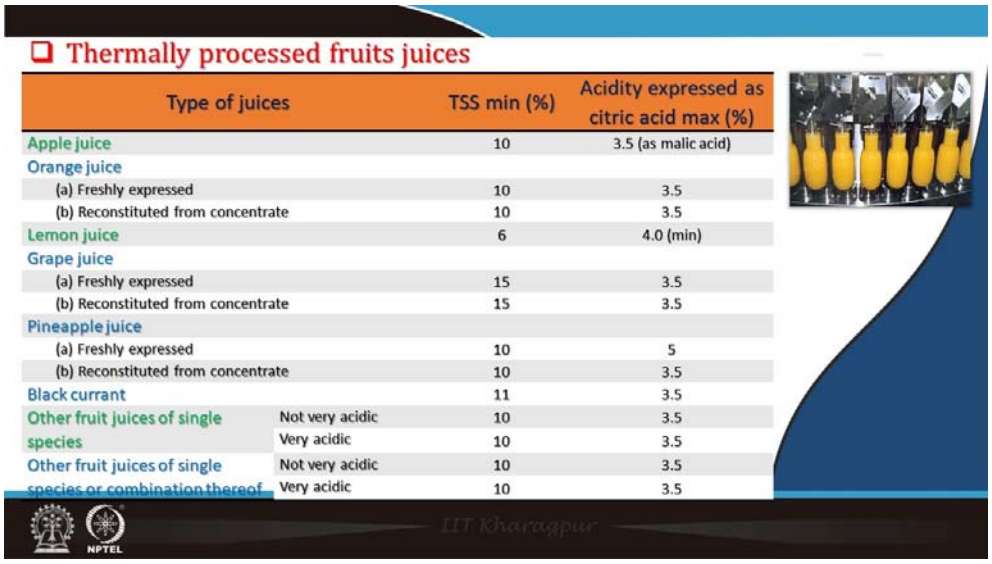
Thermally processed vegetables and fruits

In the FSSAI guidelines, particularly if we talk about fruits and vegetable products, they have come up with certain standards for various processed fruits and vegetable products. Some examples of thermally processed vegetables and fruits and their criteria's are, in canned tomatoes, the pH should be greater than 4.5. The calcium chloride is being used as a firming agent with ion concentration less than 0.045% and sodium chloride less than 3% was used in packaging.



Similarly, in tomato juice, its TSS should be less than 0.05% exclusive of salt. Sodium chloride should be less than 3% by weight and sugar content less than 42%, titratable acidity less than 10%, volatile acidity less than 0.4%, and pH should be less than 4.5.

In the case of vegetable soups, they can be fermented or unfermented. The TSS should be less than 5% except for tomato soup where it is less than 7%. In fruit beverages, the TSS should be less than 10%. The fruit juice content, in the case of lime and lemon should be less than 5% and for other fruits, it should be less than 10%.

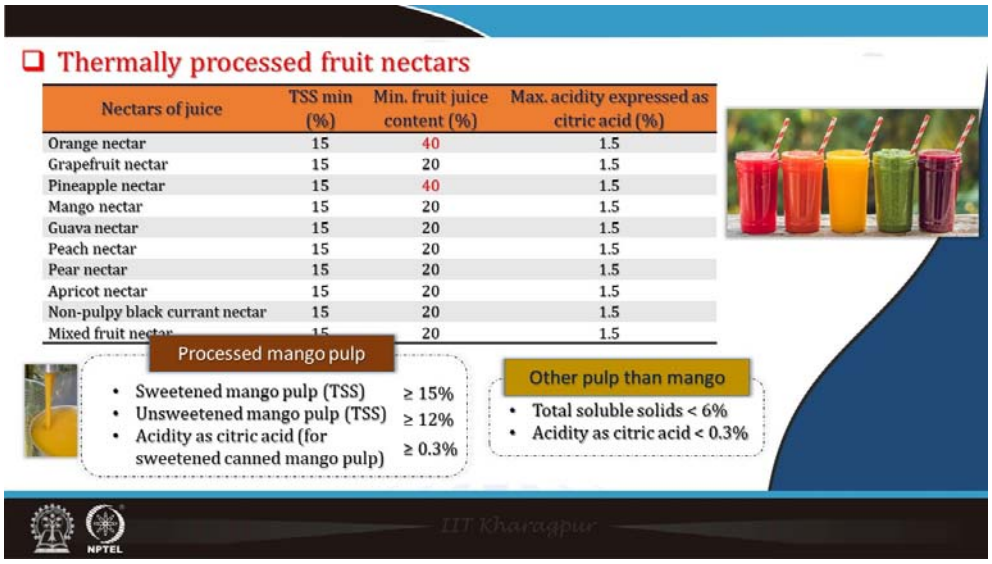


Type of juices		TSS min (%)	Acidity expressed as citric acid max (%)
Apple juice		10	3.5 (as malic acid)
Orange juice			
(a) Freshly expressed		10	3.5
(b) Reconstituted from concentrate		10	3.5
Lemon juice		6	4.0 (min)
Grape juice			
(a) Freshly expressed		15	3.5
(b) Reconstituted from concentrate		15	3.5
Pineapple juice			
(a) Freshly expressed		10	5
(b) Reconstituted from concentrate		10	3.5
Black currant		11	3.5
Other fruit juices of single species	Not very acidic	10	3.5
	Very acidic	10	3.5
Other fruit juices of single species or combination thereof	Not very acidic	10	3.5
	Very acidic	10	3.5

Thermally processed fruit juices

In the table shown below, different juices, their minimum TSS content, and maximum acidity. For apple juice, the minimum TSS is 10% and maximum acidity should be 3.5% as malic acid. In orange juice, it should contain 10% TSS and 3.5 % acidity both for freshly expressed or reconstituted from concentrate. Similarly, in the lemon juice TSS should be 6% minimum and acidity is 4 minimum. The grape juice whether it is freshly expressed or reconstituted from

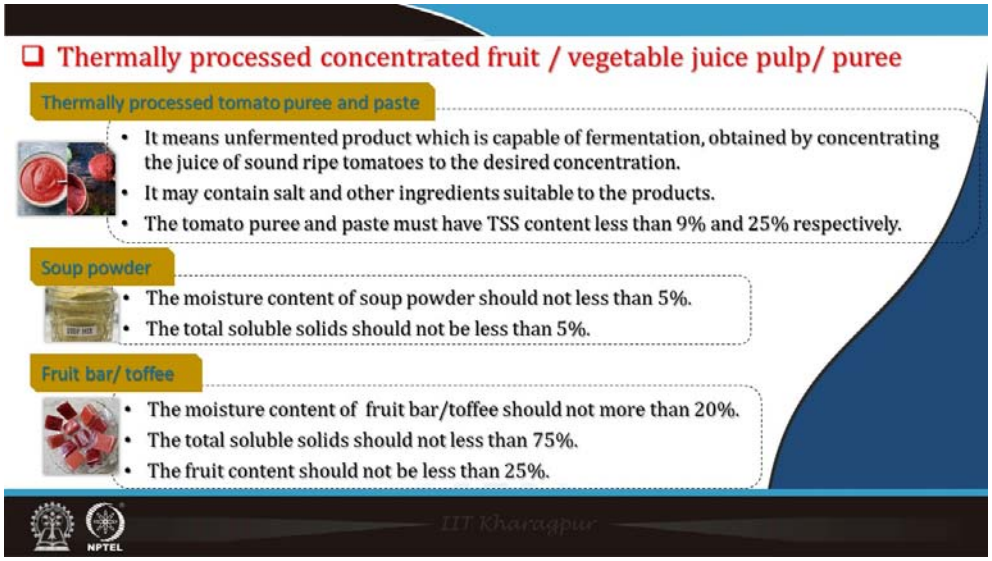
concentrate, it should have minimum TSS of 15% and the maximum acidity expressed in citric acid of 3.5. In general, the pH or acidity should be around 3.5% maximum and the TSS may be 10% minimum except lemon or lime.



Thermally processed fruit nectars

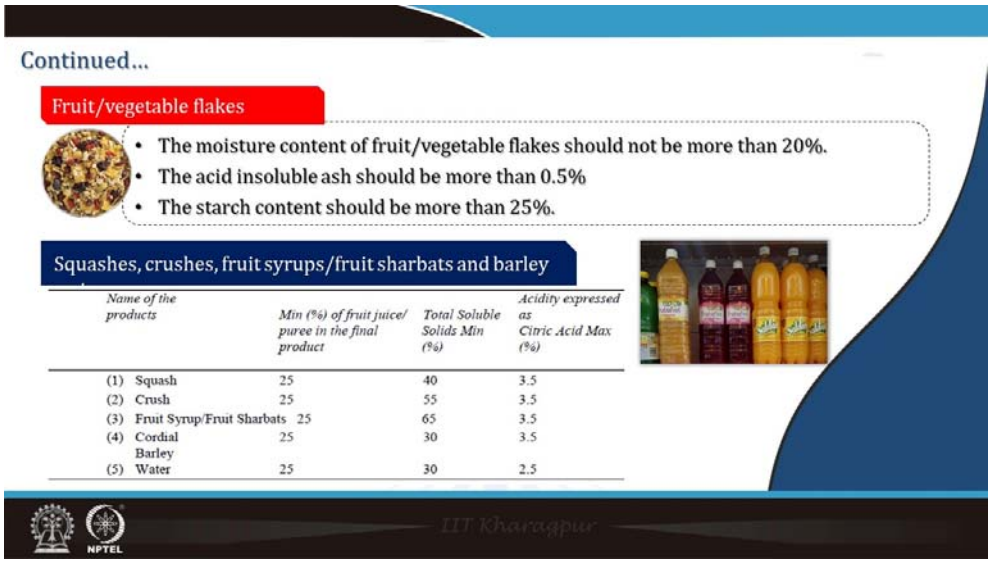
The table shown has variety of fruit nectars, their minimum TSS and fruit juice content, as well as maximum acidity. The orange nectar or pineapple nectar contains minimum 40% fruit juice. Others fruit nectars have minimum 20% fruit juice content. The TSS and acidity is same for all the nectar i.e. TSS of 15% and acidity of 1.5% expressed as citric acid.

For mango pulp, TSS changes with maturity or sweetening as sweetened mango pulp has minimum 15% TSS whereas unsweetened mango pulp has 12%. Acidity for sweetened mango pulp is more than or equal to 0.3%. For other pulps, TSS should not be more than 6% and acidity 0.3%.

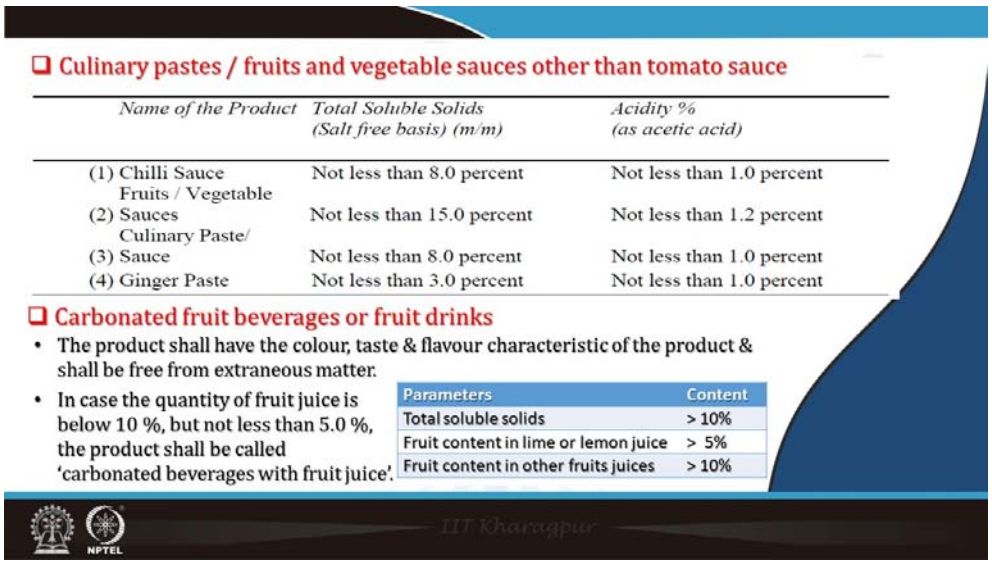


Thermally processed concentrated fruit/vegetable juice pulp/puree

For thermally processed tomato puree and paste, unfermented product which is capable of fermentation obtained by concentrating the juice of the sound ripe tomato or to the desired concentration is required. It may contain salt and other ingredients suitable to the products. The tomato puree and paste must have TSS content less than 9% and 25% respectively. In soup powder, the moisture content and TSS should be not less than 5%. The moisture content of fruit bar or toffee should not be more than 20% with minimum TSS of 75% and fruit content of 25%. In fruit/vegetable flakes, the moisture content should not be more than 20%. The acid insoluble should be more than 0.5% and starch content should be more than 25%.

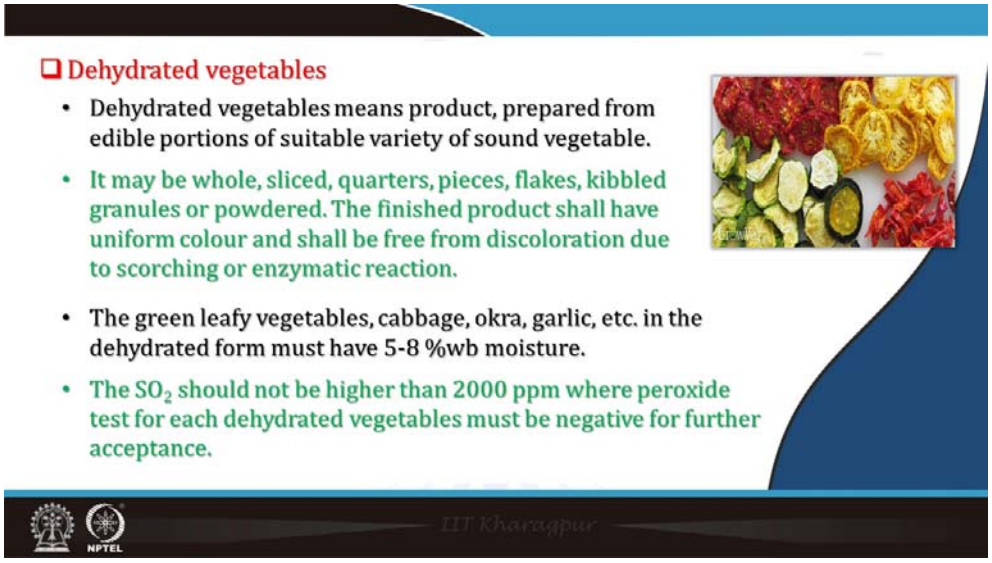


Similarly, squashes, crushes, fruit syrups, fruit sharbat and barley etc. have minimum 25% of fruit juice puree in the final product. The TSS differs based on product such as squash (40%), crush (55%), fruit syrup (65%), cordial and water (30%). The acidity is 3.5% for all except water which has 2.5%.



In the case of culinary paste fruits and vegetable sauces other than tomato sauce, the TSS and acidity is given in the table. For example, chili sauce, the TSS should not be less than 8% and acidity should not be less than 1%. In ginger paste, minimum TSS is 3% and acidity is 1%.

For carbonated fruit beverages, the product shall have the color, taste and flavor characteristics of the product and the product shall be free from any extraneous matter. In carbonated fruit drinks, the quantity of fruit juices is below 10% but not less than 5%. So, the total soluble solid would be more than 10%. Fruit content in the lime or lime juice should be more than 5% and fruit content in other fruit juices should be more than 10%.

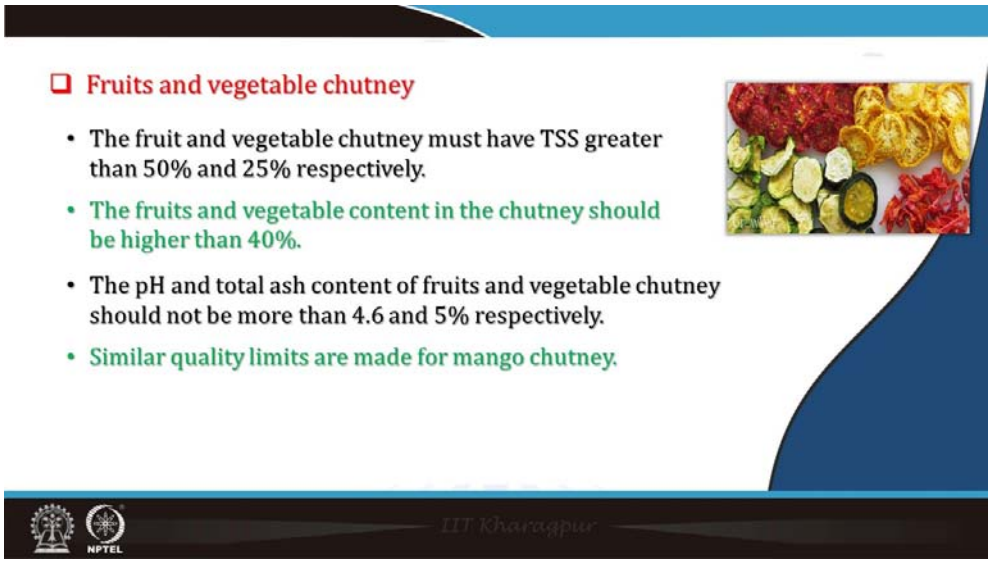


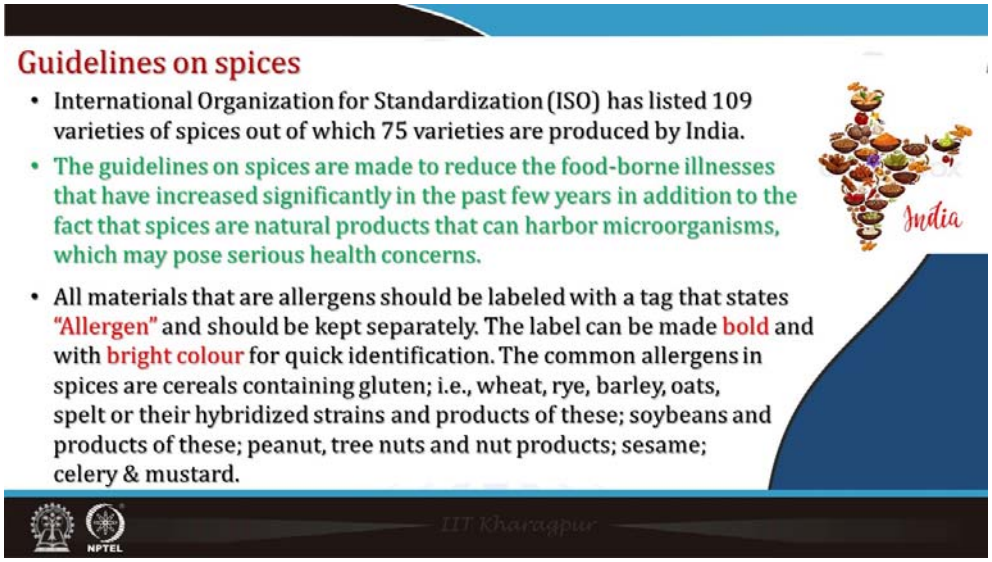
Dehydrated vegetables

The dehydrated vegetable means the product prepared from edible portion of suitable variety of sound vegetables. It may be whole, sliced, quarters, flaked, kibbled, granules or powdered. The finished product shall have uniform color and shall be free from discoloration due to scorching or enzymatic reactions. The green leafy vegetables, cabbage, okra, garlic etc. in the dehydrated form must contain moisture about 5 to 8%. The sulfur dioxide which is used in these fruit or vegetable for preservation should not be higher than 2000 ppm where peroxide test for each dehydrated vegetable must be negative for further acceptance.

Fruit and vegetable chutney

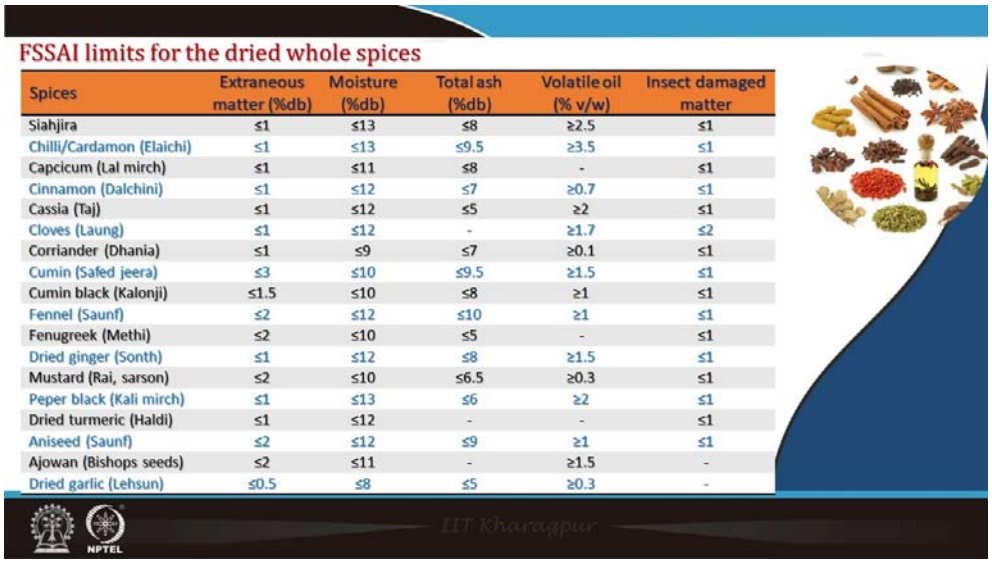
The fruits and vegetable chutney prepared must have TSS greater than 50% and 25% respectively. The fruits and vegetable content in the chutney should be higher than 40%. The pH and the total ash content of fruits and vegetables chutney should not be more than 4.6 and 5% respectively. Similar quality limits are made for mango chutney as well.





Guidelines on spices

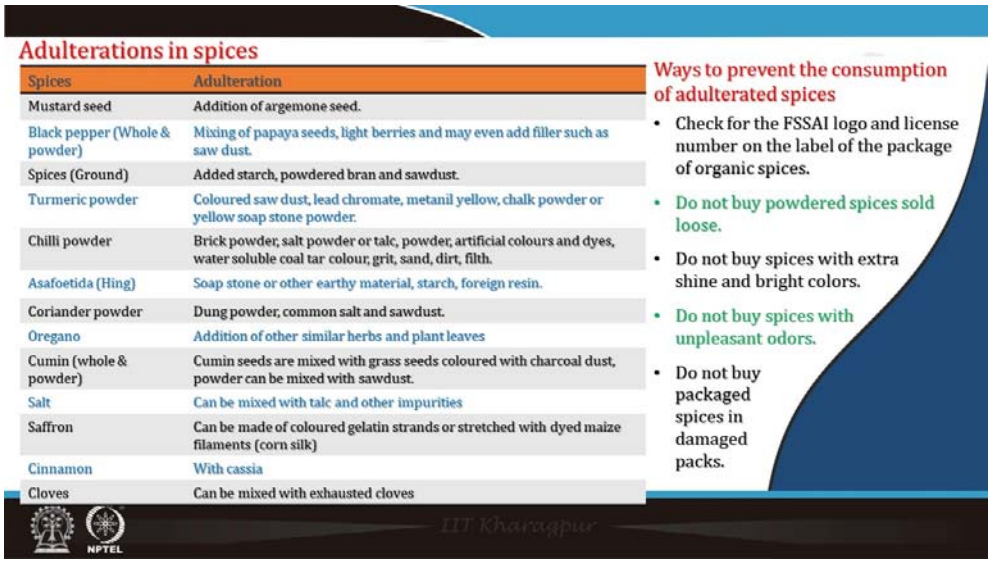
The major guidelines on spices as per the International Organization for Standardization (ISO). There are 109 varieties of spices listed in ISO and out of which 75 varieties are produced in India. The guidelines on spices are made mainly to reduce the food-borne illnesses that have increased in the past few years. Although many of these spices do contain that antibacterial agents but still molds etc. grows on them. So, all material that are allergens should be labeled with a tag that states "Allergen" and it should be kept separately. The label can be made bold and bright in color for quick identification. The common allergens in the spices are the cereals containing gluten, i.e. wheat, rye, barley, oats, spelt or their hybridized strains and products of these; products of these peanut, tree nut and nut products, sesame, celery and mustard etc.



Spices	Extraneous matter (%db)	Moisture (%db)	Total ash (%db)	Volatile oil (% v/w)	Insect damaged matter
Siahjira	≤1	≤13	≤8	≥2.5	≤1
Chilli/Cardamon (Elaichi)	≤1	≤13	≤9.5	≥3.5	≤1
Capcicum (Lal mirch)	≤1	≤11	≤8	-	≤1
Cinnamon (Dalchini)	≤1	≤12	≤7	≥0.7	≤1
Cassia (Taj)	≤1	≤12	≤5	≥2	≤1
Cloves (Laung)	≤1	≤12	-	≥1.7	≤2
Corriander (Dhania)	≤1	≤9	≤7	≥0.1	≤1
Cumin (Safed jeera)	≤3	≤10	≤9.5	≥1.5	≤1
Cumin black (Kalonji)	≤1.5	≤10	≤8	≥1	≤1
Fennel (Saunf)	≤2	≤12	≤10	≥1	≤1
Fenugreek (Methi)	≤2	≤10	≤5	-	≤1
Dried ginger (Sonth)	≤1	≤12	≤8	≥1.5	≤1
Mustard (Rai, sarson)	≤2	≤10	≤6.5	≥0.3	≤1
Peper black (Kali mirch)	≤1	≤13	≤6	≥2	≤1
Dried turmeric (Haldi)	≤1	≤12	-	-	≤1
Aniseed (Saunf)	≤2	≤12	≤9	≥1	≤1
Ajowan (Bishops seeds)	≤2	≤11	-	≥1.5	-
Dried garlic (Lehsun)	≤0.5	≤8	≤5	≥0.3	-

FSSAI limits for the dried whole spices

As per the FSSA guidelines for dried whole spices, various spices contain extraneous matter which needs to be reduced to less than 2 or even 1%. Moisture, total ash, volatile oil and insect damaged matter have been specified under the guidelines for various spices, dehydrated spices. For example chili or cardamom (elaichi) should not contain extraneous matter more than 1%. Moisture content should be less than or equal to 13%, total ash less than 9.5%, volatile oil more than 3.5% and insect damaged matter less than 1%. Similarly, in the case of cumin seed (safed jira), extraneous matter should be less than 3%, moisture less than 10%, total ash less than 9.5%, volatile oil greater than 1.5% and insect damaged matter less than 1%. So, various guidelines for different spices, dried spices, these limits are prescribed. One may refer the FSSAI guidelines available on their website and other various literatures category.

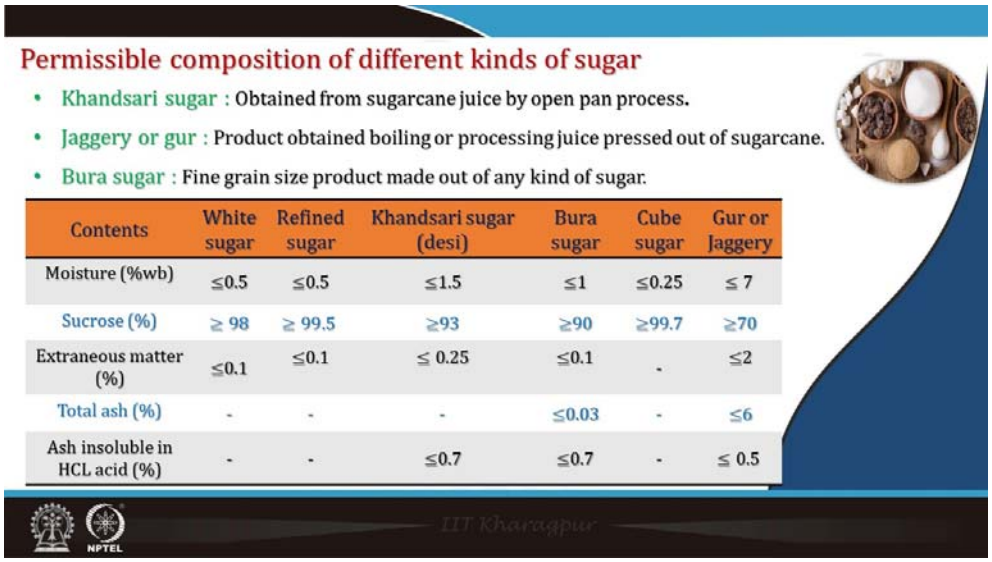


Spices	Adulteration
Mustard seed	Addition of argemone seed.
Black pepper (Whole & powder)	Mixing of papaya seeds, light berries and may even add filler such as saw dust.
Spices (Ground)	Added starch, powdered bran and sawdust.
Turmeric powder	Coloured saw dust, lead chromate, metanil yellow, chalk powder or yellow soap stone powder.
Chilli powder	Brick powder, salt powder or talc, powder, artificial colours and dyes, water soluble coal tar colour, grit, sand, dirt, filth.
Asafoetida (Hing)	Soap stone or other earthy material, starch, foreign resin.
Coriander powder	Dung powder, common salt and sawdust.
Oregano	Addition of other similar herbs and plant leaves
Cumin (whole & powder)	Cumin seeds are mixed with grass seeds coloured with charcoal dust, powder can be mixed with sawdust.
Salt	Can be mixed with talc and other impurities
Saffron	Can be made of coloured gelatin strands or stretched with dyed maize filaments (corn silk)
Cinnamon	With cassia
Cloves	Can be mixed with exhausted cloves

Adulteration in spices

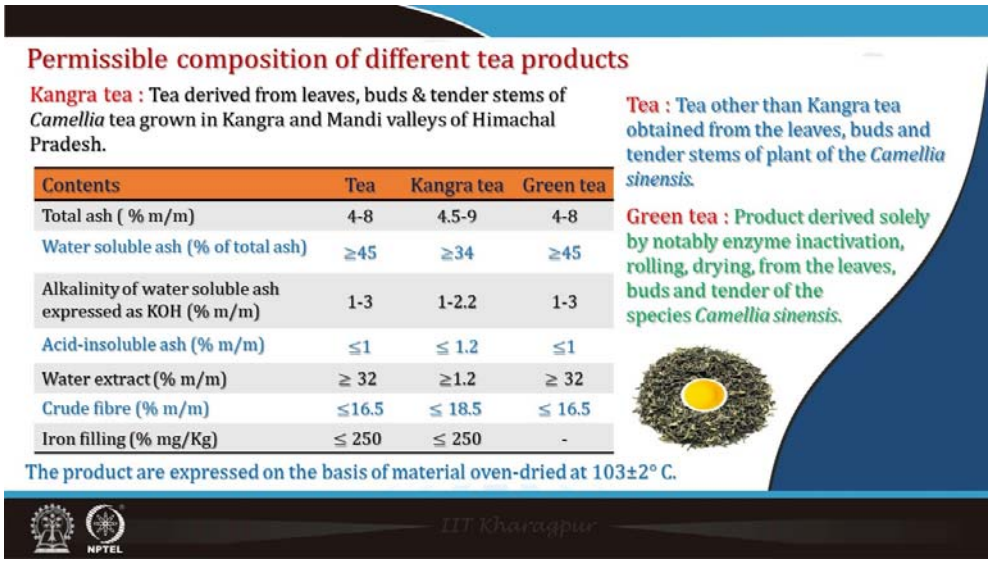
In the case of spices, adulteration is common. In mustard seeds, argemone seeds are added.

Chili powder has many adulterants such as brick powder, salt powder or talc, artificial colors etc. Starch powder, sawdust are added in ground spices. Cinnamon can be adulterated with cassia. Cloves can be mixed with exhausted cloves. There are various tests to conduct or check the adulterants present in spices. Some common precautions that the consumer can take are check the FSSAI logo and license number on the label of the package of the organic spices, do not buy powder the spices sold loose, do not buys spices with extra sign and bright color, do not buy any spices with unpleasant odors or do not buy the packaged spices where the package is damaged. There are provisions in the FSSAI guidelines and standards for their punishment.



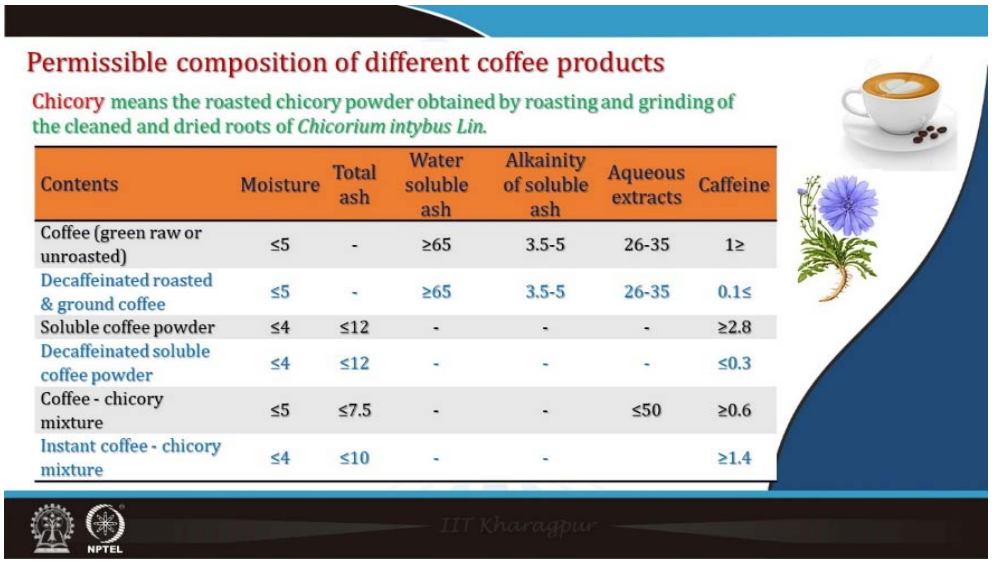
Permissible composition of different kinds of sugar

The permissible composition of different kinds of sugar for use in different products in the fruits and vegetable processing may be khandsari sugar, which is originated from sugarcane juice by the open pan process; jaggery or gur, which is the product obtained by boiling or processing of the juice pressed out of sugarcane; and bura sugar is the very fine grain size products made out of any kind of sugar. FSSAI has formulated guidelines for different kinds of sugar which are shown in table. For example, jaggery or gur should not have moisture content more than 7% with 70% or more sucrose and less than 2% extraneous matter. Total ash should be less than or equal to 6% and ash insoluble in HCl acid should be equal to or less than 0.5%. Similarly, each sugar type has different guidelines.



Permissible composition of different tea products

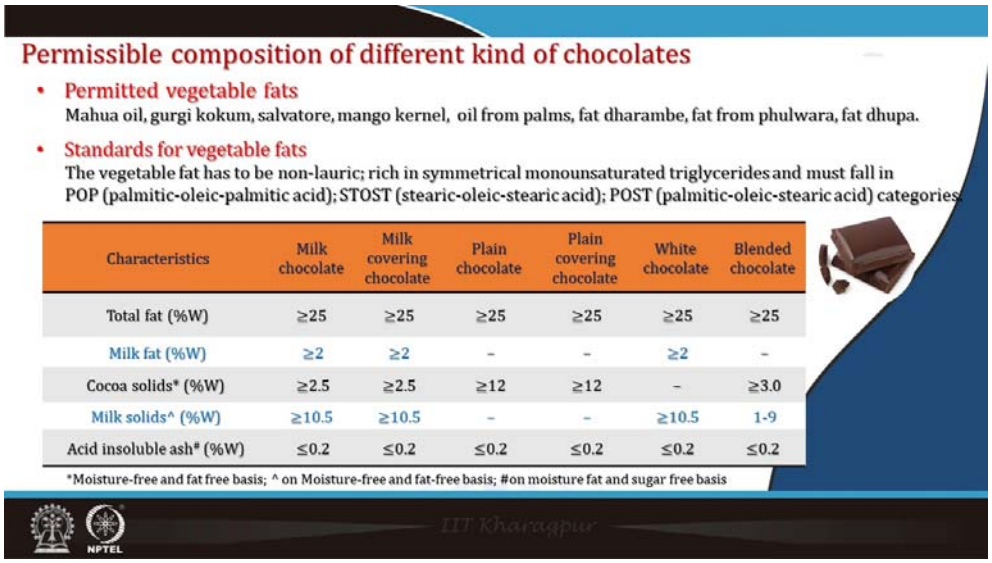
Similarly, the different permissible composition for different tea products by FSSAI is shown. Kangra tea, the tea derived from leaves, buds and tender stems of the *Camellia* tea grown in Kangra and Mandi valleys of Himachal Pradesh whereas the tea other than the Kangra is obtained from the leaves, buds and tender stems of plants of the *Camellia sinensis*. Green tea is the product derived solely by notably enzyme inactivation, rolling, drying, from the leaves, buds and tender stems of the species *Camellia sinensis*. So, the various contents standard like total ash (% m/m) in general should be in the range of 4 to 8%. In the Kangra tea, it is recommended 4.5 to 9%. Water soluble ash (% of total ash) or acid insoluble ash (% m/m) or even crude fiber (% m/m), iron filings (% mg/kg) etc. are prescribed standards for these asset and some of these values are given here in this table.



Permissible composition of different coffee products

Similarly, some permissible components or guidelines or standards for the different coffee

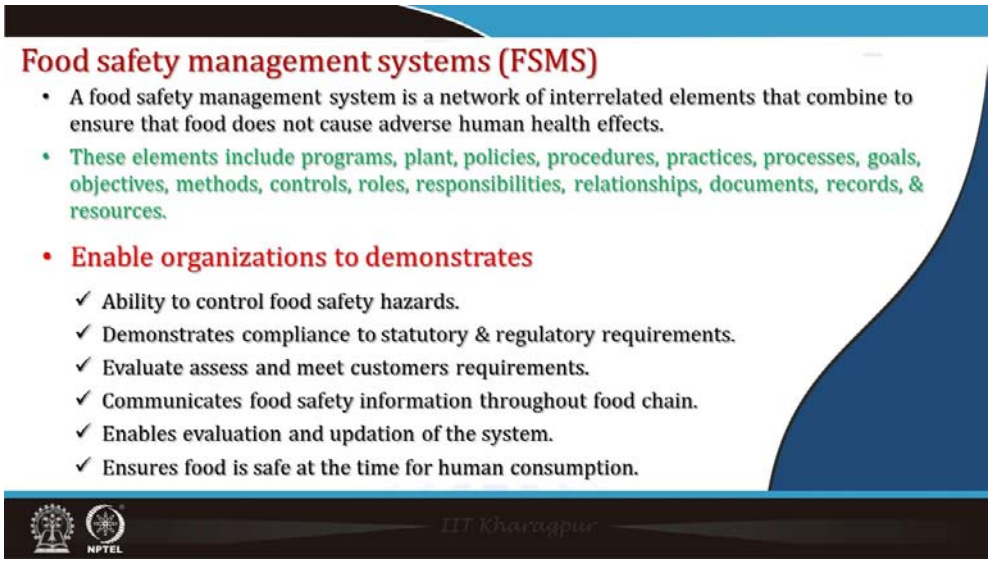
products and in the coffee product as per the FSSAI guidelines is shown in the given table. Chicory powder is permitted to be mixed. Chicory means the roasted chicory powder which is obtained by roasting and grinding of the cleaned and dried roots of *Cichorium intybus Lin.* The moisture content, total ash, water soluble ash, alkali soluble ash, aqueous extracts, and caffeine content are standardized for coffee. For example caffeine should be less than or equal to 1% in the green raw or unroasted coffee. The moisture in the all types of coffee should be in approximately less than 4 or 5%. Total ash should be less than or equal to 12% in the case of soluble coffee powder or decaffeinated soluble coffee powder and it should be less than or equal to 7.5 percent in coffee-chicory mixture or less than or equal to 10% in instant coffee-chicory mixture.



Permissible composition of different kind of chocolates

The permitted vegetable fats in the chocolates are mahua oil, gurgi kokum, savatore, mango kernel, oil from palms etc. The standards for the vegetable fats to be mixed in the chocolates should be that the vegetable fat has to be non-lauric, rich in symmetrical monounsaturated triglycerides and must fall in POP (palmitic-oleic-palmitic acid), STOST (stearic-oleic-stearic acid) or POST (palmitic-oleic-stearic acid) categories. So, the content i.e. the characteristics of the milk chocolate, milk recovering chocolate, plain chocolate, plain covering chocolate, white chocolate, and blended chocolate were checked for a total 5 fat types viz. total fat (%), milk fat (%), cocoa solids (%), milk solids (%), and acid insoluble ash (%). All these are specified like in all the cases, total fat should be more than or equal to 25% and acid insoluble ash should be less than or equal to 0.2%. Milk fat was not used in plain or white chocolate and in milk chocolates, it should be greater than or equal to 2%. Other than white chocolate, all the chocolates contain cocoa solids with minimum 12% in plain and 2.5 to 3% in milk chocolates. Milk solids in milk chocolate, milk covering chocolate and white chocolate is greater than or

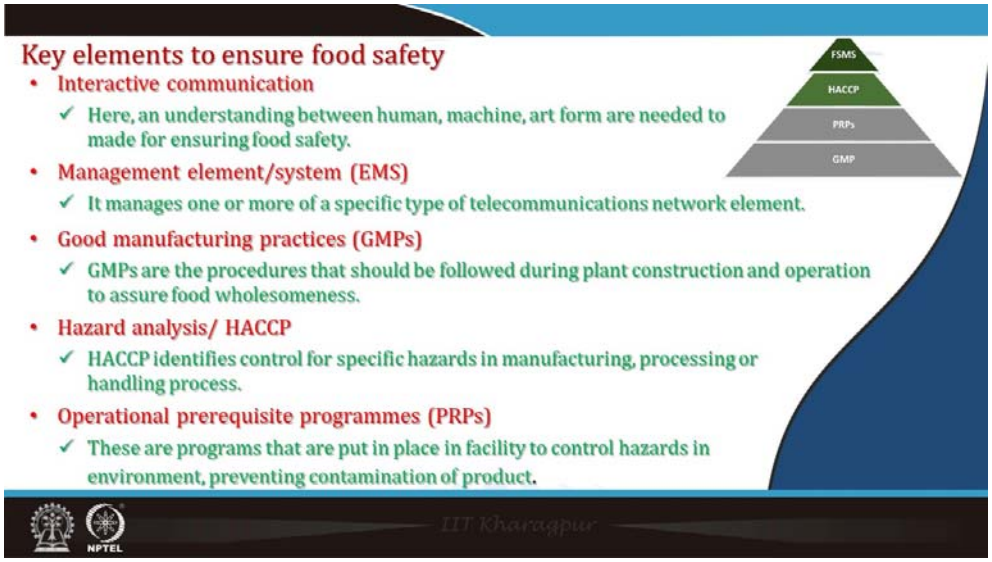
equal to 10.5% and in blended chocolate it should be in the range of 1 to 9%.



Food safety management system (FSMS)

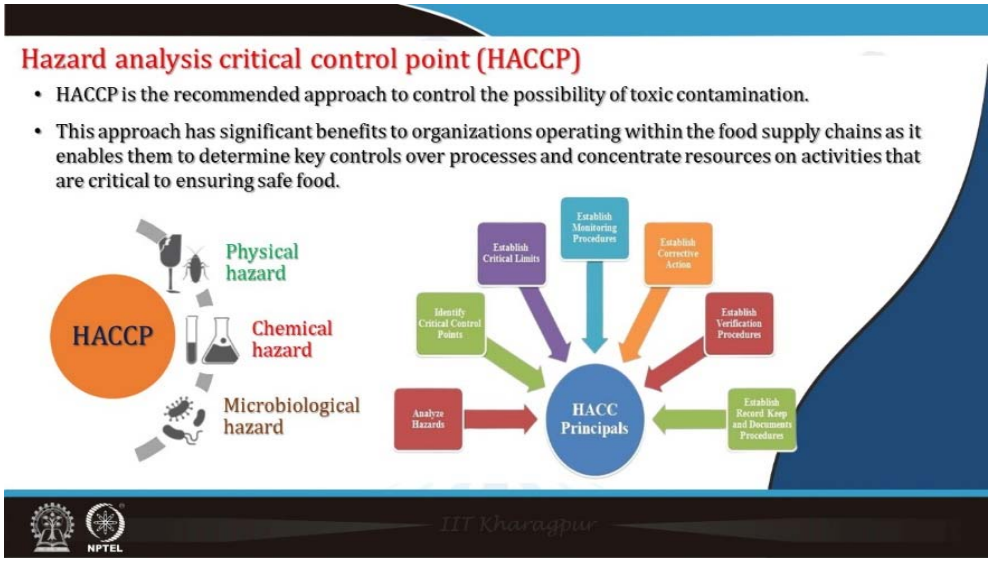
A FSMS is a network of interrelated elements that combine to ensure that the food does not cause any adverse human health effect when it is eaten. These elements include programs, plants, policies, procedures, practices, processes, goals, objectives, methods, controls, roles, responsibilities, relationships, documents, records, & resources. All these things should be done either at the manufacturer level, at the regulator level or at the company.

Enable organizations to demonstrate their ability to control food safety standards, to demonstrate compliance to statutory and regulatory requirements, evaluate assess and meet customer requirements, communicates food safety information throughout the food chain, enables evaluate and updation of the system and ensure food is safe at the time of consumption.



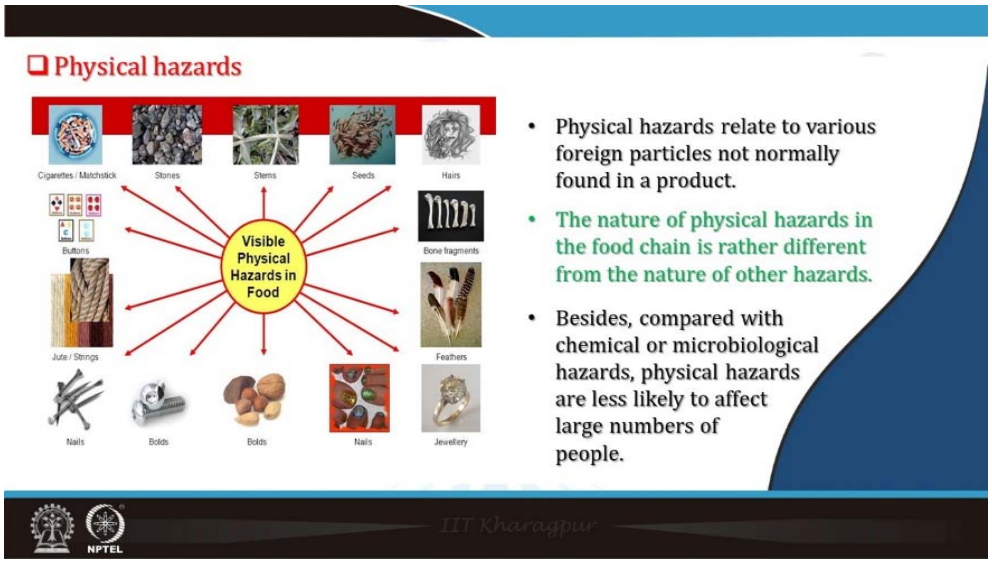
Key elements to ensure food safety

There are five key elements to ensure food safety which are interactive communication, management element/system (EMS), good manufacturing practices (GMP), HACCP, and operational prerequisite programmes (PRPs). Interactive communication is where there is proper understanding and interaction between human, machines to ensure food safety. EMS manages one or more specific types of telecommunication network element. GMP are the procedures that should be followed during plant construction as well as operation of the plant to assure food wholesomeness to ensure production of safe food. Then hazard analysis or HACCP that defines control for specific hazards in manufacturing, processing or handling process. Operational prerequisite programs (PRPs) are the programs that are put in place in facility to control hazards in environment, preventing contamination of products.



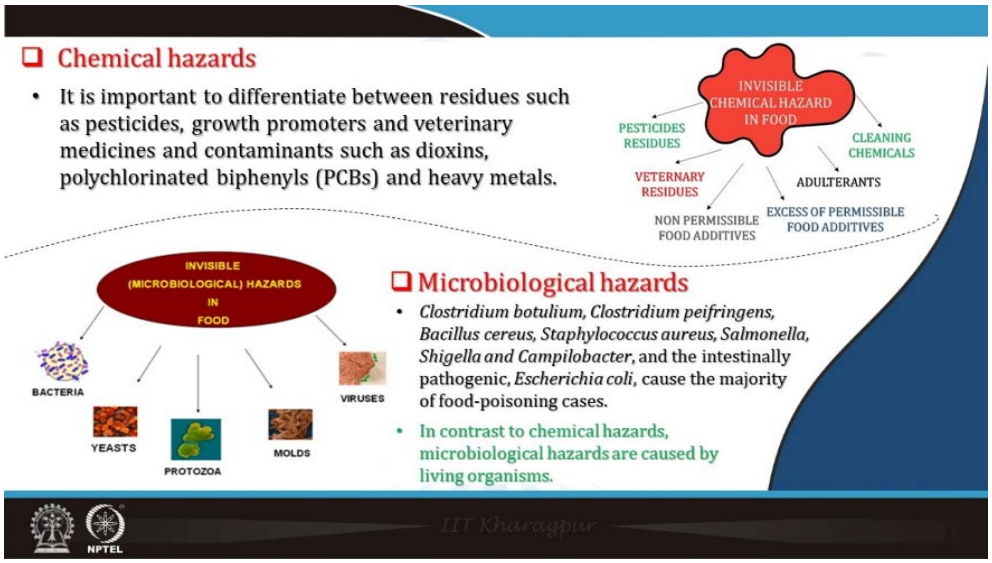
Hazard Analysis and Critical Control Point (HACCP)

HACCP is the recommend approach to control the possibility of any toxic contaminations or any hazardous matters present in the food. This approach has significant benefits to organizations operating within the food supply chains as it enables them to determine key controls over processes and concentrate resources on activities that are critical to ensure a safe food. The food may contain hazards like physical hazards, chemical hazard or microbial hazard and therefore every possible approach should be taken to control minimize this hazards. There are seven principles of HACCP protocol according to which the first is the analyze the hazards, other physical, biological, chemical, etc., and then identify the critical control point in the process chain or in the value chain, establish the critical limit, establish monitoring process, establish corrective action, establish a verification procedure and finally established record keeping and document practices.



Physical hazards

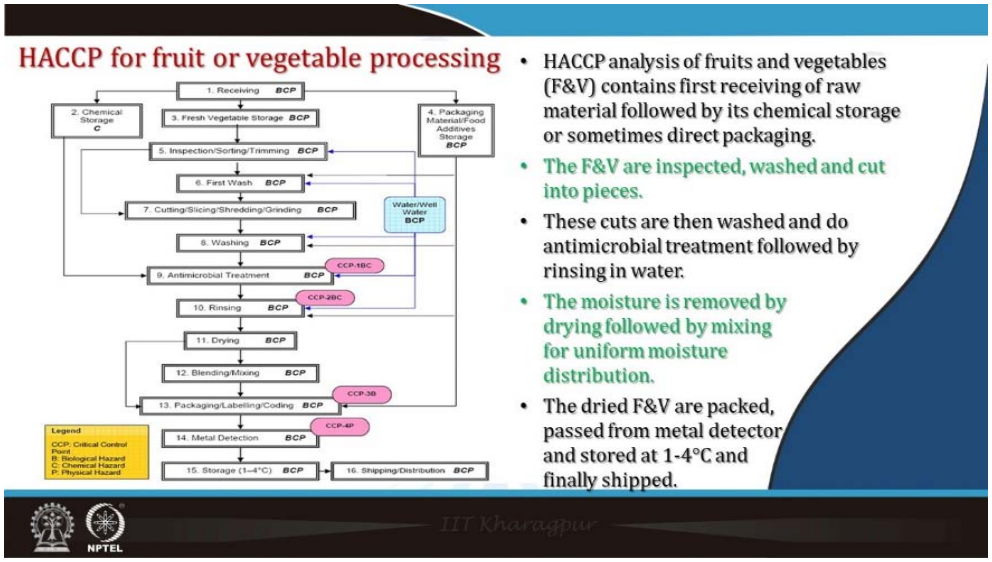
Physical hazards relate to various foreign particles not normally found in the product. The nature of the physical hazards in the food chain is rather different from the nature of the other hazards. Besides, compared with the chemical or microbiological hazards, physical hazards are less likely to affect large number of people. The various physical sources of the hazards are cigarettes, matchsticks, stones, stems, seeds, hairs, buttons, bone fragments, nails, bolds, bolts etc.



Chemical & Microbiological hazards

Chemical hazards are important to differentiate between the residues such as pesticides, growth promoters, and veterinary medicines, contaminants such as dioxin, polychlorinated biphenyls (PCBs) and heavy metals. Microbiological hazards are bacteria, yeast, protozoa, mold, viruses such as *Clostridium botulium, Clostridium peifringens, Bacillus cereus, Staphylococcus aureus, Salmonella, Shigella and Campilobacter*, and the intestinally pathogenic, *Escherichia coli*,

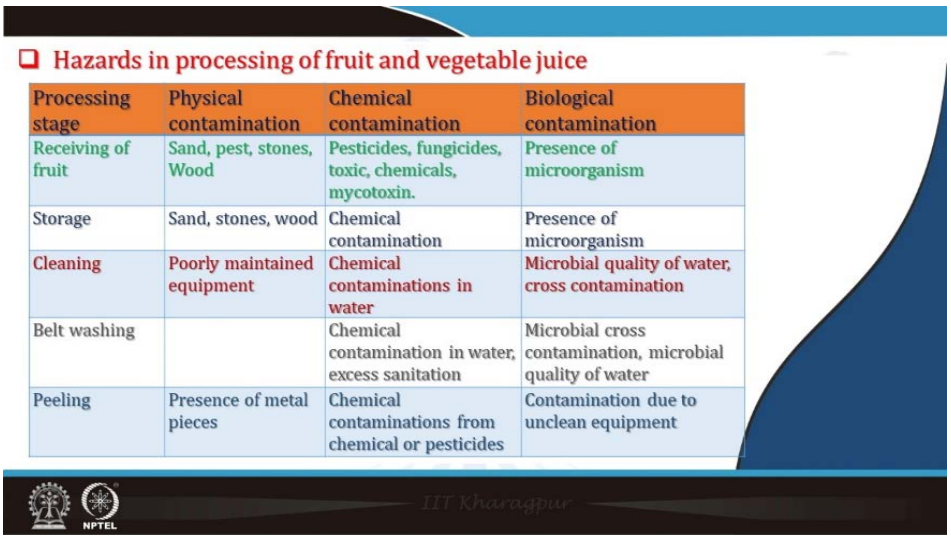
cause the majority of food-poisoning cases. Anything which come in contact with the fruit, vegetable or food during the production or post production they may create hazards.



HACCP for fruit or vegetable processing

HACCP analysis of fruits and vegetables (F&V) contains first receiving of raw material followed by its chemical storage or sometimes direct packaging. The biological hazard or the chemical hazard are important or where the physical hazards are there that is these are the indicated by BCP, and then the whole value chain particularly where CCP, one should take care of critical control points which are shown in the figure.

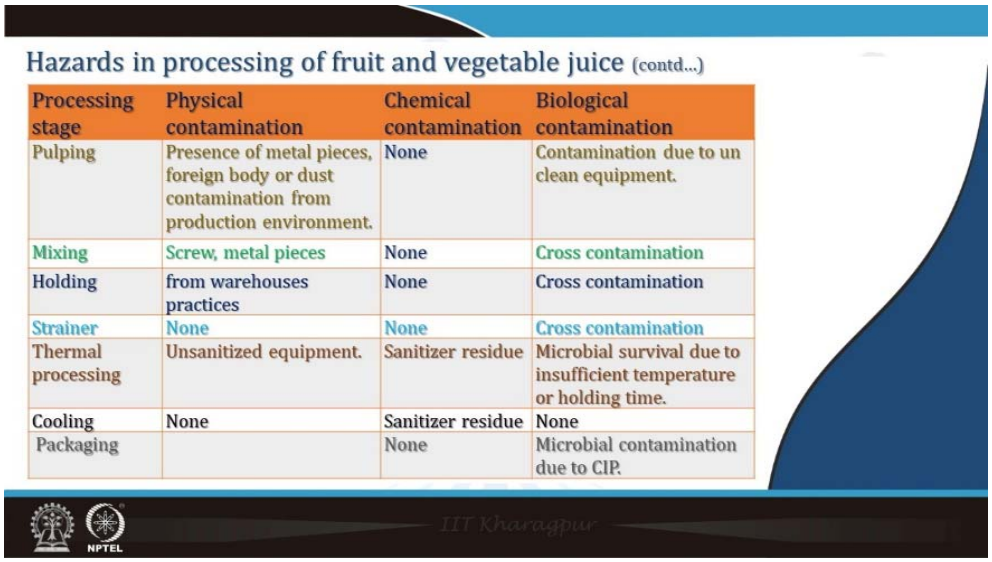
The process starts from receiving of the raw material followed by its chemical storage or sometimes even direct packaging. So, they are inspected, washed, cut into pieces and finally, moisture is removed, followed by mixing etc. At each and every stage, appropriate measures should be taken to check the hazards in the value chain particularly which are vulnerable to allow the growth of microorganisms though it may become zero if the final product is sterilized.



Processing stage	Physical contamination	Chemical contamination	Biological contamination
Receiving of fruit	Sand, pest, stones, Wood	Pesticides, fungicides, toxic, chemicals, mycotoxin.	Presence of microorganism
Storage	Sand, stones, wood	Chemical contamination	Presence of microorganism
Cleaning	Poorly maintained equipment	Chemical contaminations in water	Microbial quality of water, cross contamination
Belt washing		Chemical contamination in water, excess sanitation	Microbial cross contamination, microbial quality of water
Peeling	Presence of metal pieces	Chemical contaminations from chemical or pesticides	Contamination due to unclean equipment

Hazards in processing of fruit and vegetable juice

In the given table, details of hazards in processing of fruit and vegetable juice is given at each processing stage from receiving the fruit till packaging. Different physical, chemical, and biological contamination are identified at each stage. For example, during receiving of fruit, sand, pest, stones and woods are physical contamination; pesticides, fungicides, toxic chemicals are chemical contamination; microorganism presence are biological contamination. Similarly, different contaminations were found during storage, cleaning, belt washing, peeling, pulping, mixing, holding, straining, thermal processing, cooling, and packaging i.e. at each stage. In peeling, there may be presence of metal pieces i.e. peeling knives etc. or even chemical contamination come from the chemicals and pesticides, or contamination due to unclean equipment etc.

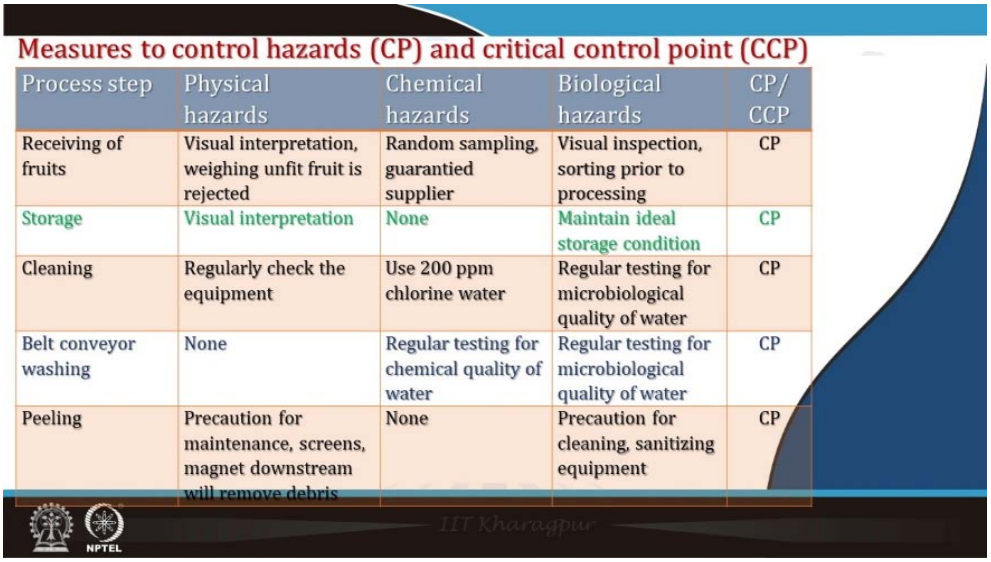


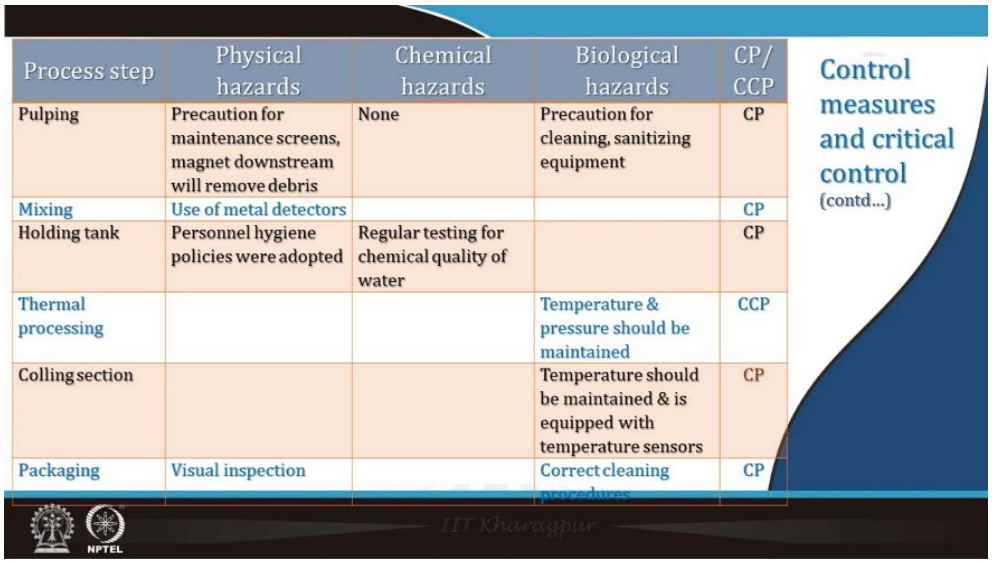
Similarly, in thermal processing, there may be physical contamination from the unsanitized equipment, chemical contamination maybe from the sanitizer residue or biological contamination maybe from microbial survivor due to insufficient temperature or holding time. So, various stages, what are the various sources from each different contamination and hazards may come.

Measures to control hazards (CP) and critical control points (CCP)

As discussed earlier, at each processing stage, there may be chances of physical, chemical or biological hazards. Thus, various measures should be taken to control these hazards. So, CP CCP are developed at each processing stage in a value chain. For example, during cleaning, equipment should be periodically checked and maintained, water should be chlorinated, and microbiological testing should be done regularly. During storage, maintain ideal storage conditions. These precautions for cleaning sanitizing equipment will prevent the biological

hazards and comes under CP. So, follow appropriate practice, appropriate cleaning, sanitizers and other practices, use proper procedures and maintain such that there is no contaminations.



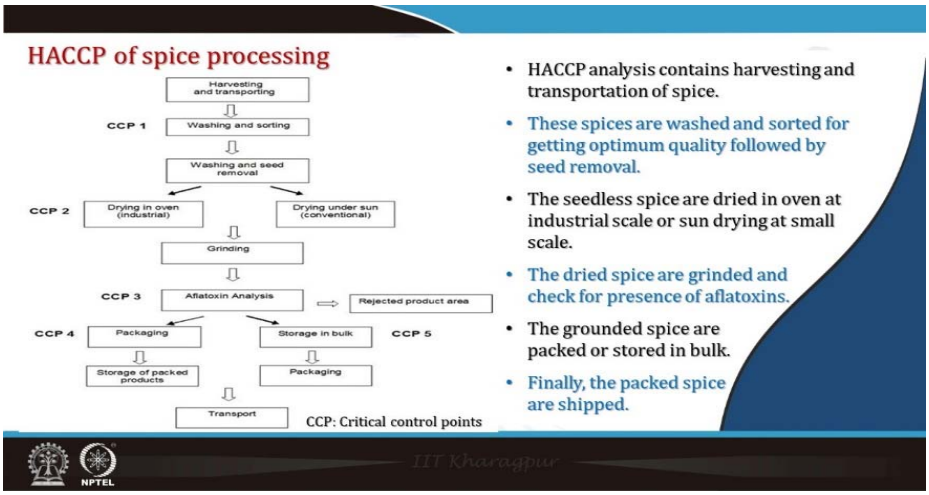


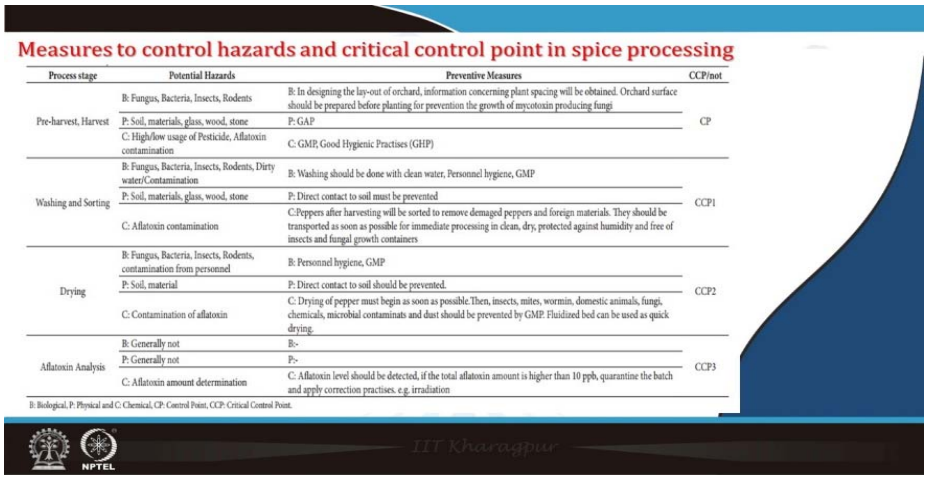
These basic processes have CP whereas in technical portion, we need CCP such as in the thermal processing, temperature and pressure should be properly maintained to get the desired sterilization or pasteurization.

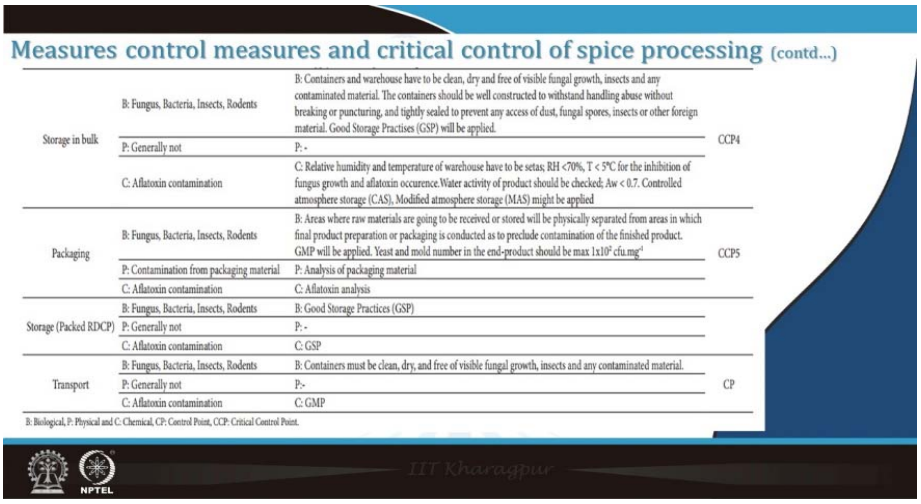
HACCP of spice processing

The HACCP of the spice processing, starting from the harvesting and transporting till it is storage, packed, dried and transported. After harvesting, these spices are washed and sorted for getting optimum quality followed by seed removal. The seedless spice are dried in oven at industrial scale or sun drying at small scale. The dried spices are grounded and checked for the presence of aflatoxin, etc., ground spices are packaged in, stored in bulk and finally the packages spices are zipped. In different stages, there will be different CCPs i.e. for each and every step

there is a CCP which needs to be properly followed.



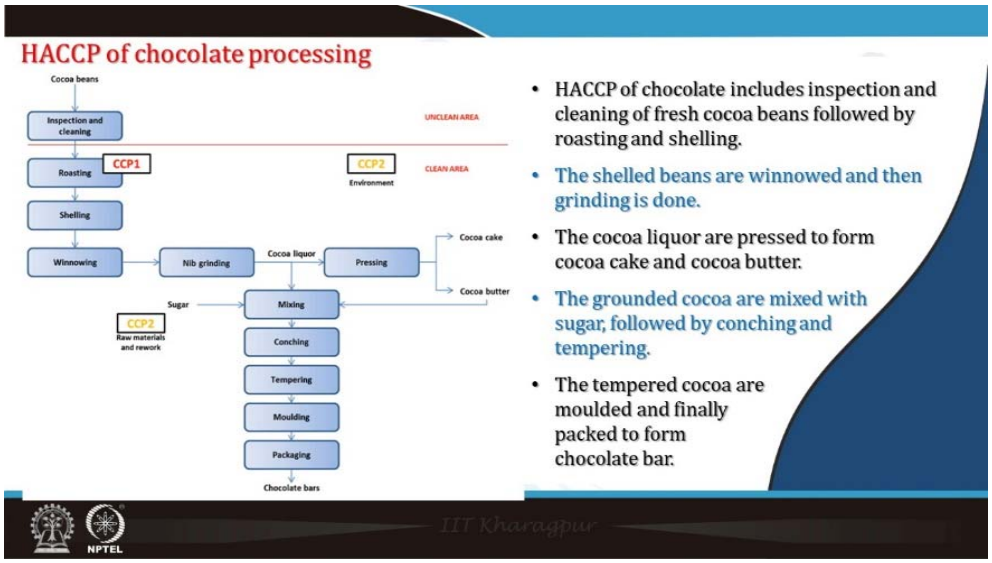




Measures to control hazards and CCP in spice processing

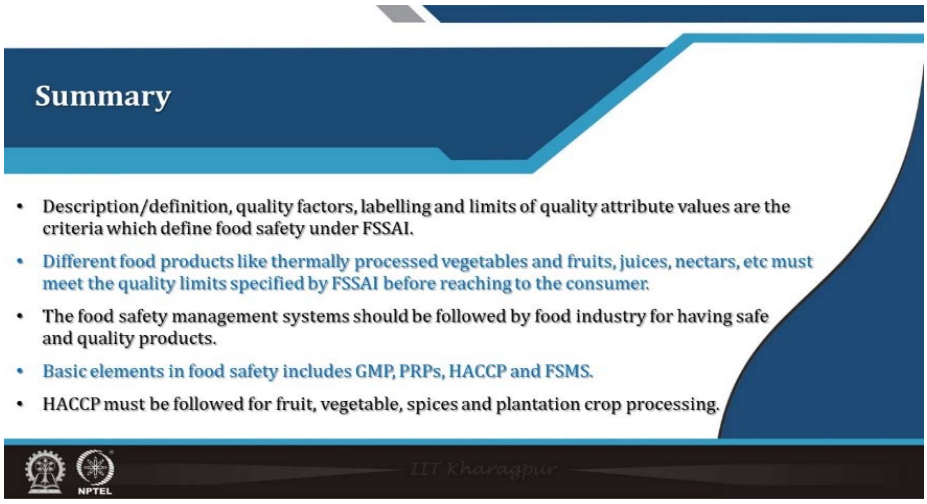
The measures to control hazards and critical control points in spice processing at various stages is shown in table. For example, in drying, the potential hazards may be fungus growth or it may be the hazards from soil, from material or contamination of aflatoxin which needs to be checked. So, the preventive measures should be taken such as direct content with the soil should be

prevented, personal hygiene (GMP) i.e. people who are involved in drying should maintain personal hygiene, and then the drying particularly for pepper should be made as soon as possible using all the necessary protocols. So, these are the various CCPs which are described in detail in the table. Similarly, in the storage, packaging, transport etc. for the spices, various stages have various critical points that needs to be controlled.



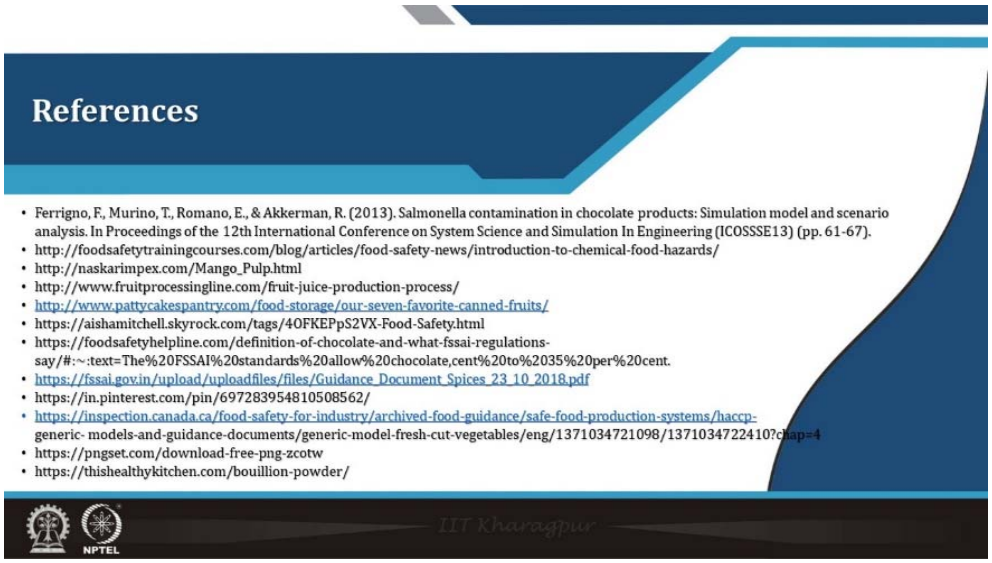
HACCP of chocolate processing

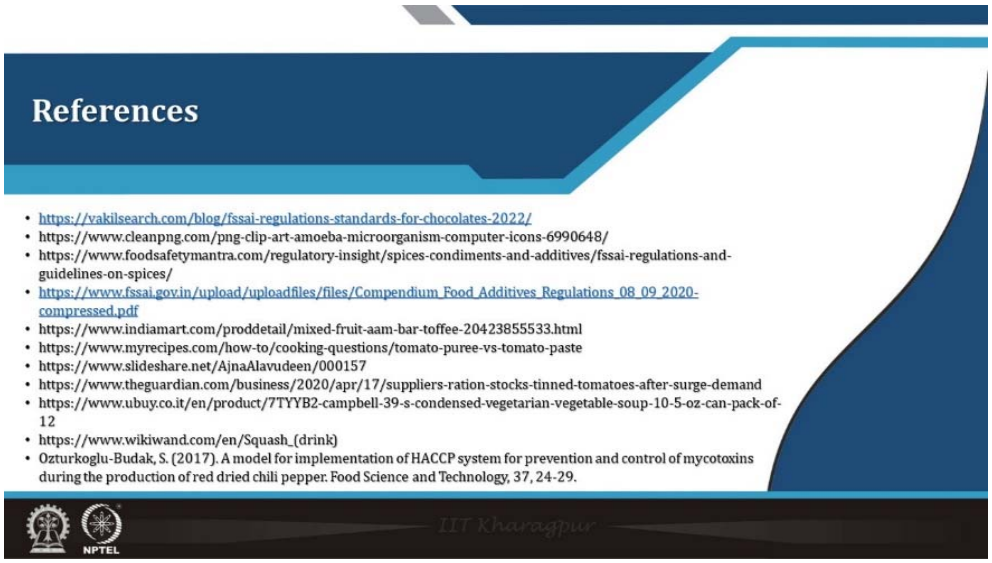
The chocolate processing as discussed earlier with different methods of the chocolate manufacturer starting from cocoa beans to bar. The HACCP of chocolate includes inspection and cleaning of fresh cocoa beans followed by roasting and shelling. So, particularly in roasting, CCP is required because it facilitated production of the flavor of the bean and also destroyed the contaminated microorganism etc. So, there is the CCP 1. Then, CCP 2 is very necessary i.e. in the environment where these processes is done should be maintained. During mixing also CCP2 was taken care of as the materials and other equipment need to be proper sanitized and manufacturing was done in proper sanitary conditions.



Summary

The FSMS guidelines are very important to ensure safety and quality of the food products. The food safety and standard authorities has the power to decide the guidelines and safety standards which needs to be updated periodically with scientific committee. The industry must follow FSSAI guidelines and it is prescribed for the particular product or commodity. Different food products like thermally processed vegetables and fruits, juices, nectars, etc. must meet the quality limits specified by FSSAI before reaching to the consumer. Basic elements in food safety includes GMP, PRPs, HACCP and FSMS. HACCP must be followed for fruit, vegetable, spices and plantation crop processing.





These are the references used in this lecture.

Thank you very much.