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

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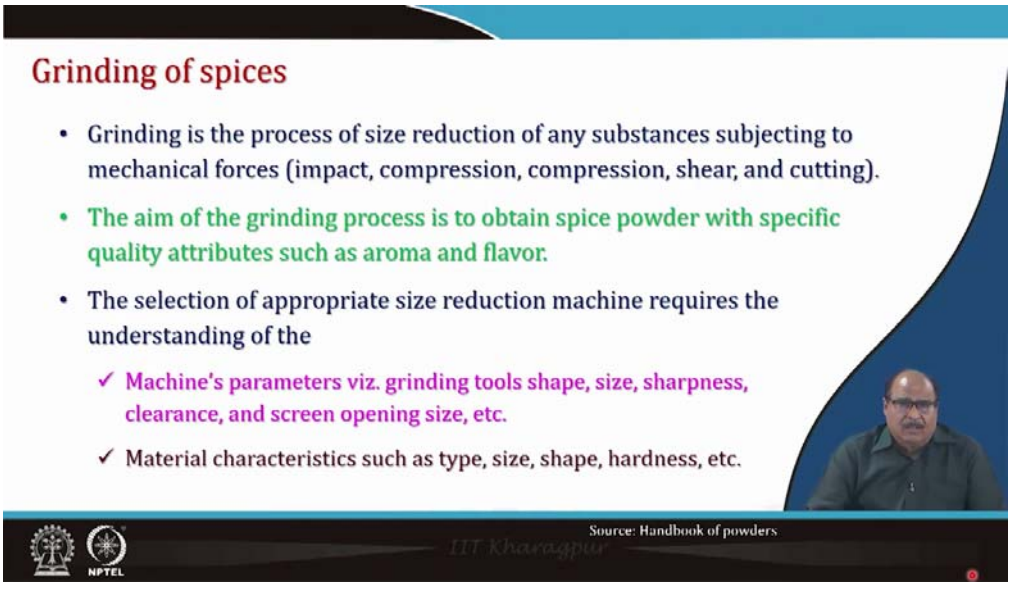
Lecture 42
Spice Powders

The concepts covered in this lecture are grinding of spices, different spice powders, sambhar powder, packaging of spice powders, and quality assurance.

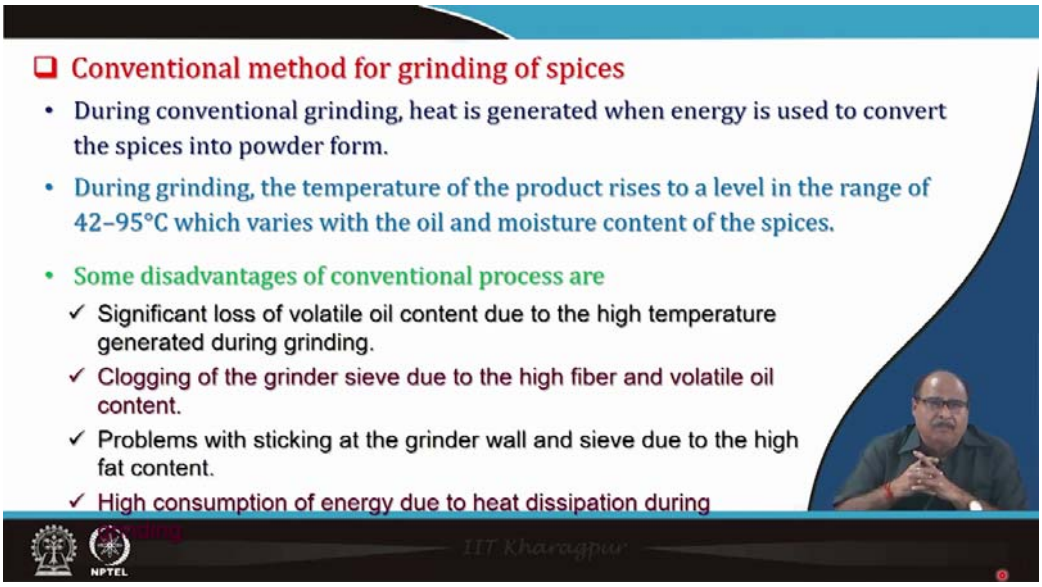
Spice powders

Spice powders are produced by grinding dried spices. Spice powders are commercially available in single or mixed form. Low moisture content and water activity allow long-term storage and the preservation of their functionalities. Different spice powders are mixed in appropriate quantities and they are sold either in the form of curry powder, sambar powder, or masala powder. There are two important things i.e. low moisture content and low water activity and presence of the antimicrobial and natural antimicrobials, makes the spices to store better for the larger period of times. However, during storage the care should be taken. Proper, appropriate methods or packaging should be done so that their functionalities are retained. So the process of producing a spice powders generally include the preparation of raw materials, processing to form powders and then miscellaneous operations like mixing, separation, agglomeration, and encapsulation.



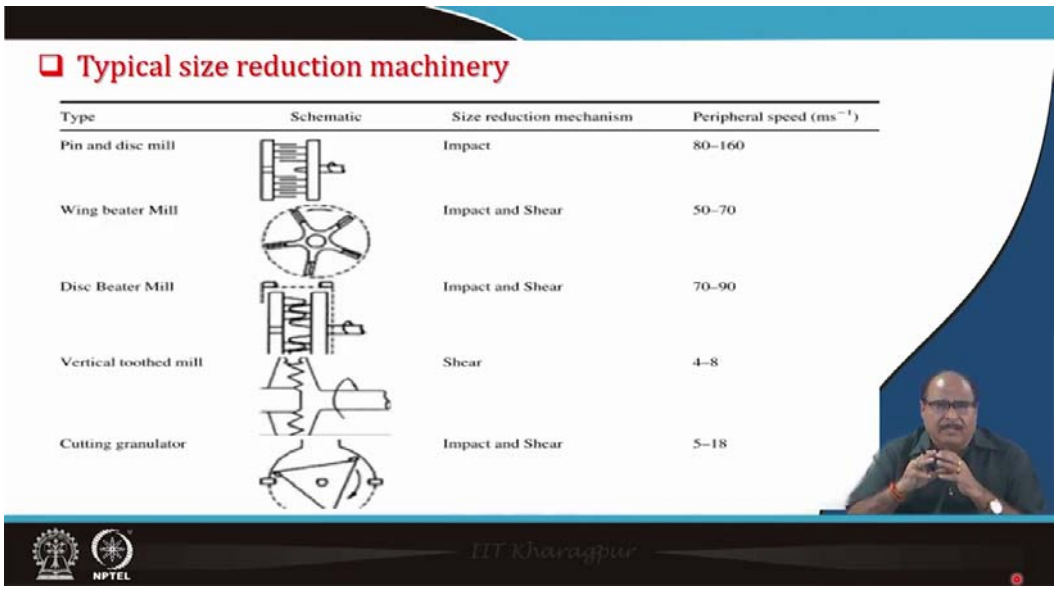
Grinding of spices

Grinding is the process of size reduction of any substances subjecting to mechanical forces (impact, compression, compression, shear, and cutting). The aim of the grinding process is to obtain spice powder with specific quality attributes such as aroma and flavor. The selection of appropriate size reduction machine requires the understanding of the machine's parameters viz. grinding tools shape, size, sharpness, clearance, and screen opening size, etc., and material characteristics such as type, size, shape, hardness, etc.



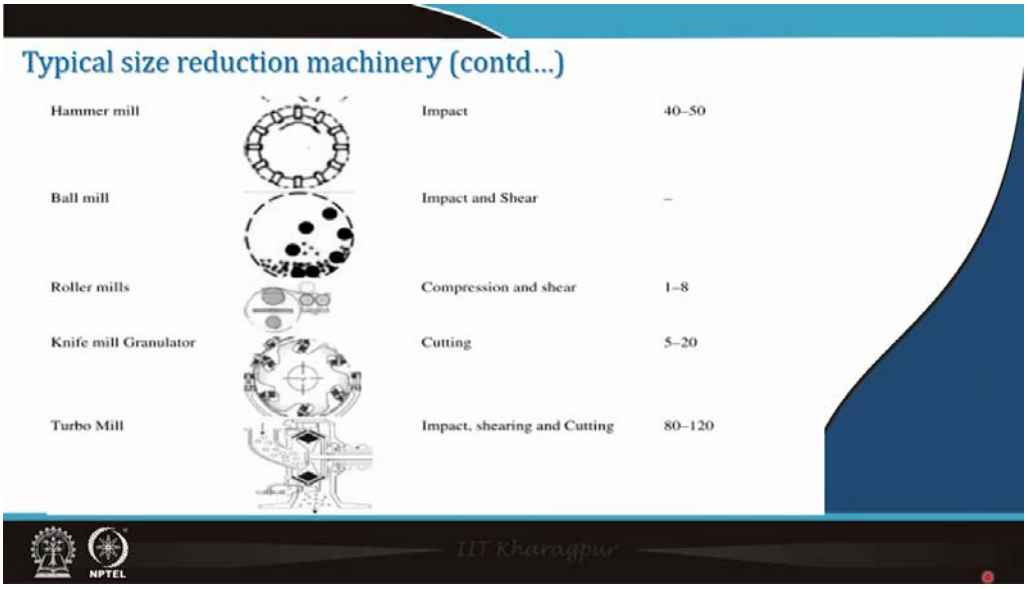
Conventional method for grinding of spices

During conventional grinding, heat is generated when energy is used to convert the spices into powder form. During grinding, the temperature of the product rises to a level in the range of 42–95°C which varies with the oil and moisture content of the spices. Some disadvantages of conventional process are significant loss of volatile oil content due to the high temperature generated during grinding, clogging of the grinder sieve due to the high fiber and volatile oil content, problems with sticking at the grinder wall and sieve due to the high fat content, high consumption of energy due to heat dissipation during grinding.

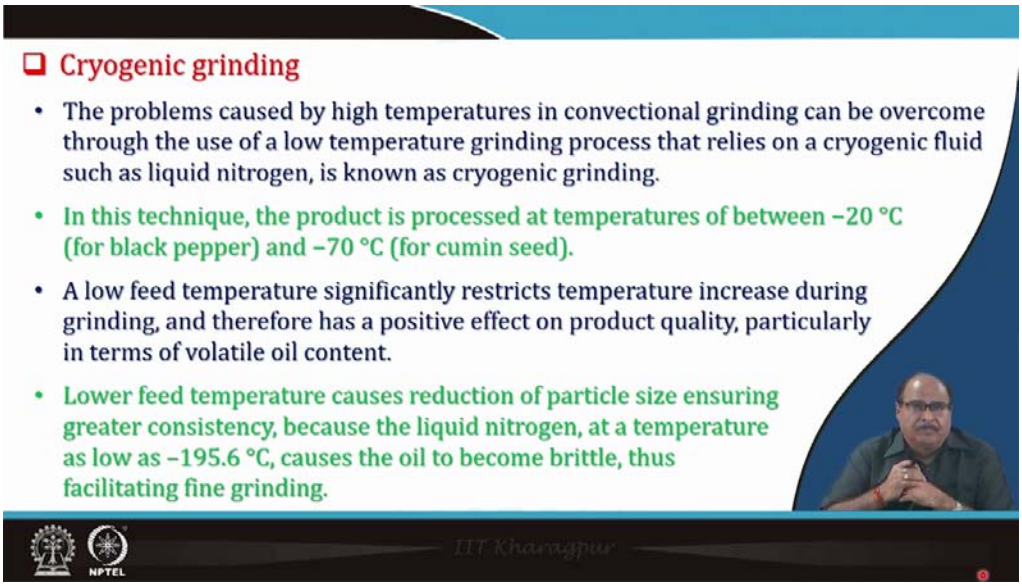


Typical size reduction machinery

The table shows the conventional machinery which are used for size reduction of the spices including their schematic diagrams, size reduction mechanisms along with their peripheral speed. For example, the size reduction mechanism involved in the pin and disc mill is impact force and the peripheral speed varies from 80-160 m/s.



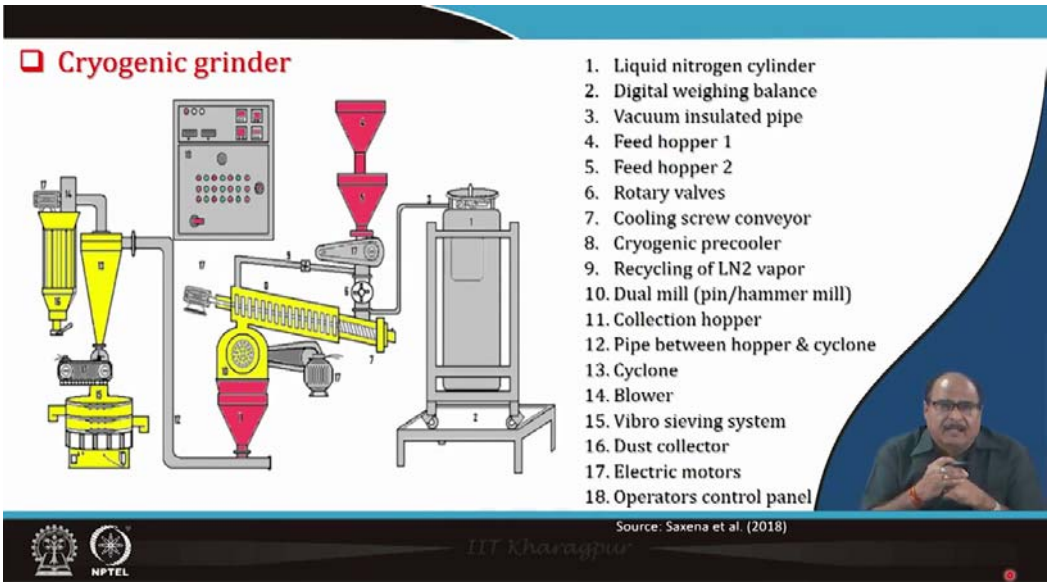
Also in the hammer mill, the impact is normally used. Ball mill involves impact and shear to reduce the particle size. Turbo mill uses impact, shear and cutting etc. for reducing the size.



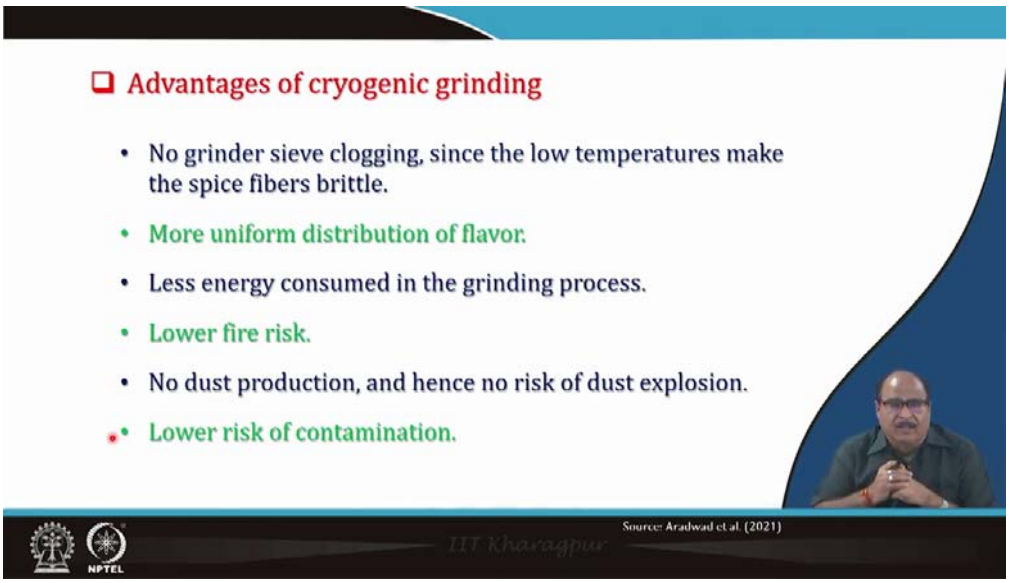
Cryogenic grinding

The problems caused by high temperatures in convectional grinding can be overcome through the use of a low temperature grinding process that relies on a cryogenic fluid such as liquid nitrogen, is known as cryogenic grinding. In this technique, the product is processed at temperatures of between −20 °C (for black pepper) and −70 °C (for cumin seed). A low feed temperature significantly restricts temperature increase during grinding, and therefore has a

positive effect on product quality, particularly in terms of volatile oil content. Lower feed temperature causes reduction of particle size ensuring greater consistency, because the liquid nitrogen, at a temperature as low as –195.6 °C, causes the oil to become brittle, thus facilitating fine grinding.

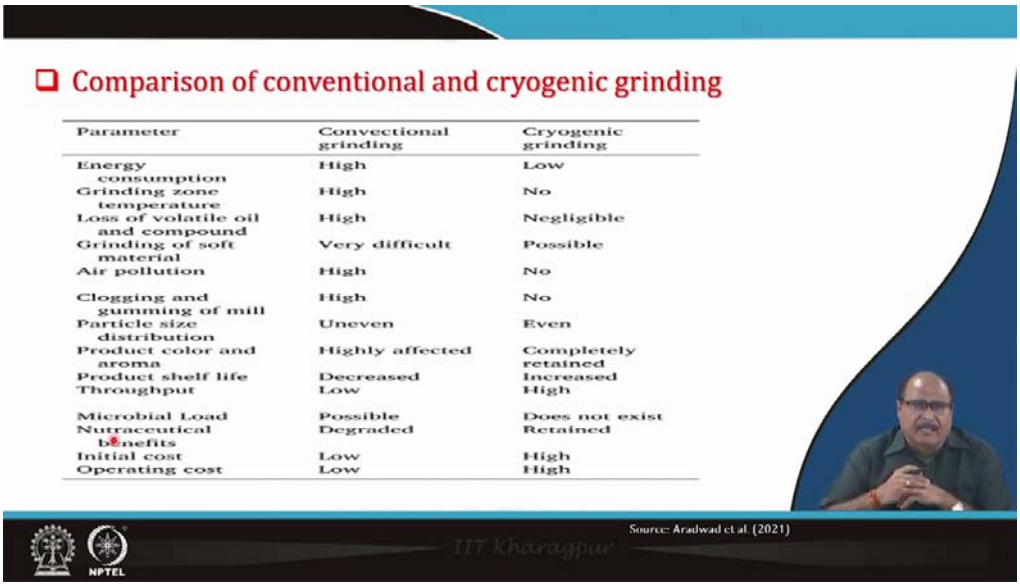


This is a schematic of a cryogenic grinding system which is a very useful machine for a spice grinding. There is a liquid nitrogen cylinder which may be some either a digital weighing balance, etc. so that the major amount of liquid nitrogen can be circulated through this connecting pipe to the spice. With the help of conveyor, the spice comes in the cryogenic pre cooler machine system where it is, it comes in direct contact, the spice comes in direct contact with the liquid nitrogen or such other coolant. So its temperature goes down and then it is passed to the grinder. In the pin mill or hammer mill, grounded spice is then taken to the cyclone separator where that is or even vibro sieving system and then the particles are separated from the, liquid nitrogen.



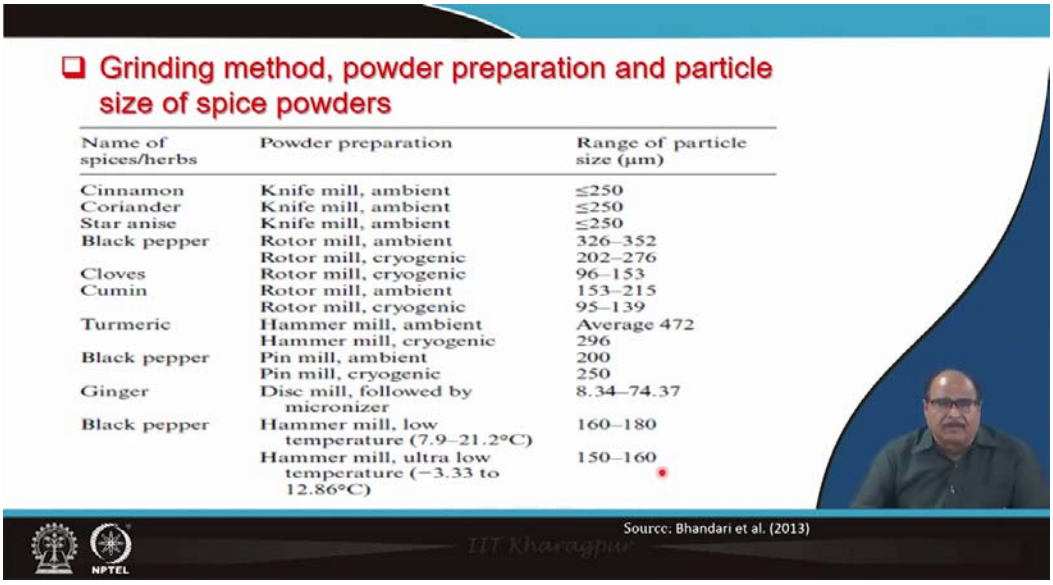
Advantages of cryogenic grinding

It has several advantages like No grinder sieve clogging, since the low temperatures make the spice fibers brittle, more uniform distribution of flavour, less energy consumed in the grinding process, lower fire risk, no dust production, and hence no risk of dust explosion, and lower risk of contamination.



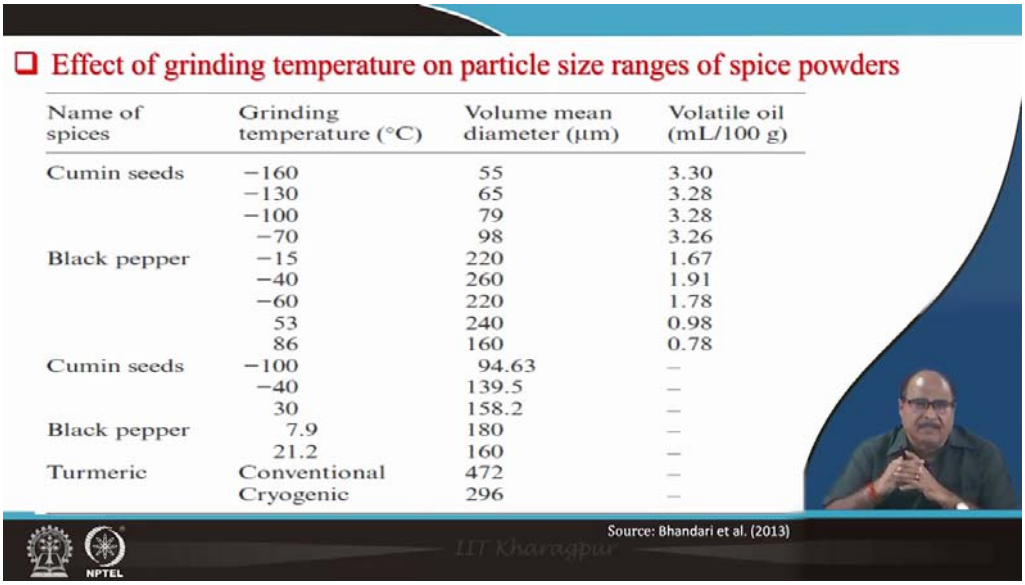
Comparison of conventional and cryogenic grinding

This table represents the comparison between the conventional grinding and cryogenic grinding. For example, the energy consumption, conventional has energy high energy consumption and cryogenic grinding low energy consumption. Similarly, grinding of the soft material is very difficult in the conventional grinding but it is possible by the cryogenic grinding. Air pollution is high in case of conventional grinding but there is no pollution in case of cryogenic grinding. Even throughput in the conventional grinding is low but in the cryogenic grinding throughput is high. Initial cost or operating cost both is low in conventional but in the cryogenic grinding initial cost as well as operating costs may be high.



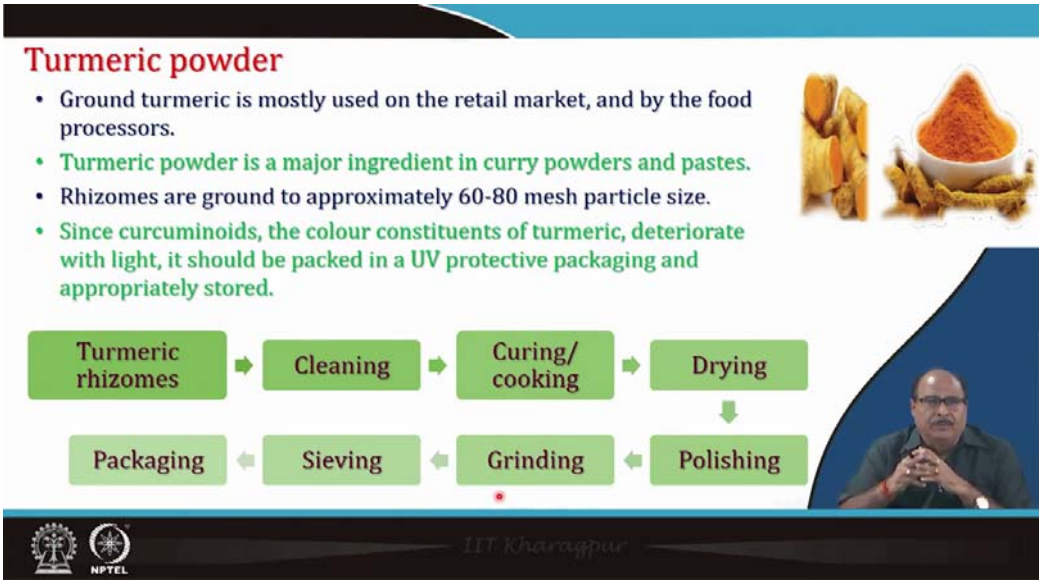
Grinding method, powder preparation and particle size of spice powders

Cinnamon, coriander, star anise, black pepper are either milled in knife mill at ambient temperature and particle size are normally around less than or equal to 250 microns is obtained. Rotor mill is used for black pepper and particle size in the range of 326 to 352 micron can be obtained. For turmeric, hammer mill is used ambient average particle size is obtained 472 microns but the hammer mill under the cryogenic system, it gives around 296 or 300 particle size.



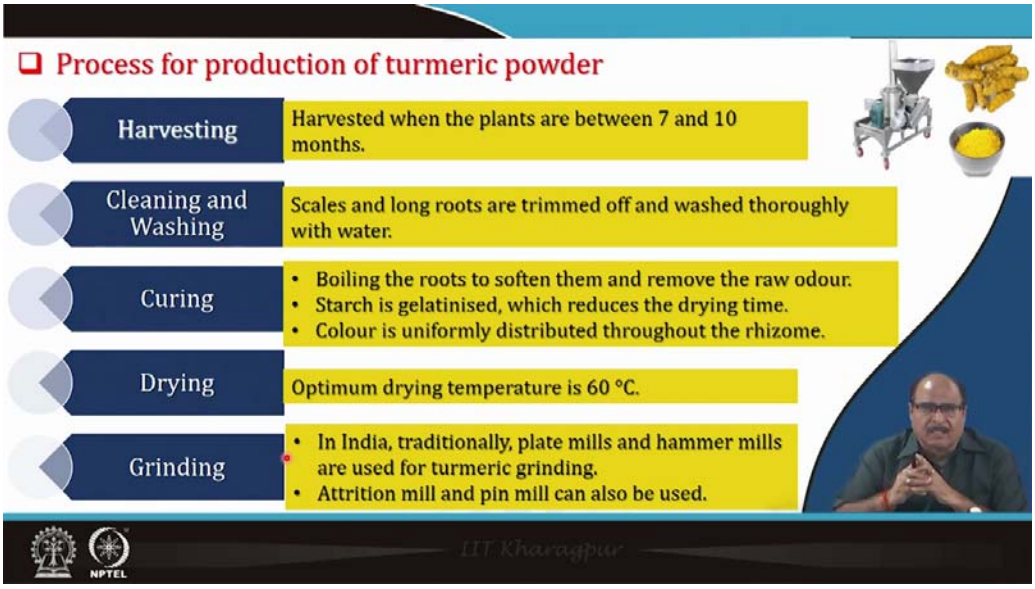
Effect of grinding temperature on particle size ranges of spice powders

As shown in the table, cumin seed if the grinding is done at minus 60 degrees Celsius, the volume mean diameter may be 55, volatile essential oil 3.3 ml per 100 gram. The same if it is grounded at minus 130 degree Celsius, the volume mean diameter will be 65. However, there is not much difference on the essential oil. But if the temperature is minus 70, the volume mean diameter is 98. So the temperature when go towards the lower side that is minus 160, at such a low temperature the volume mean diameter is the lowest.



Turmeric powder

Ground turmeric is mostly used on the retail market, and by the food processors. Turmeric powder is a major ingredient in curry powders and pastes. Rhizomes are ground to approximately 60-80 mesh particle size. Since curcuminoids, the colour constituents of turmeric, deteriorate with light, it should be packed in a UV protective packaging and appropriately stored.

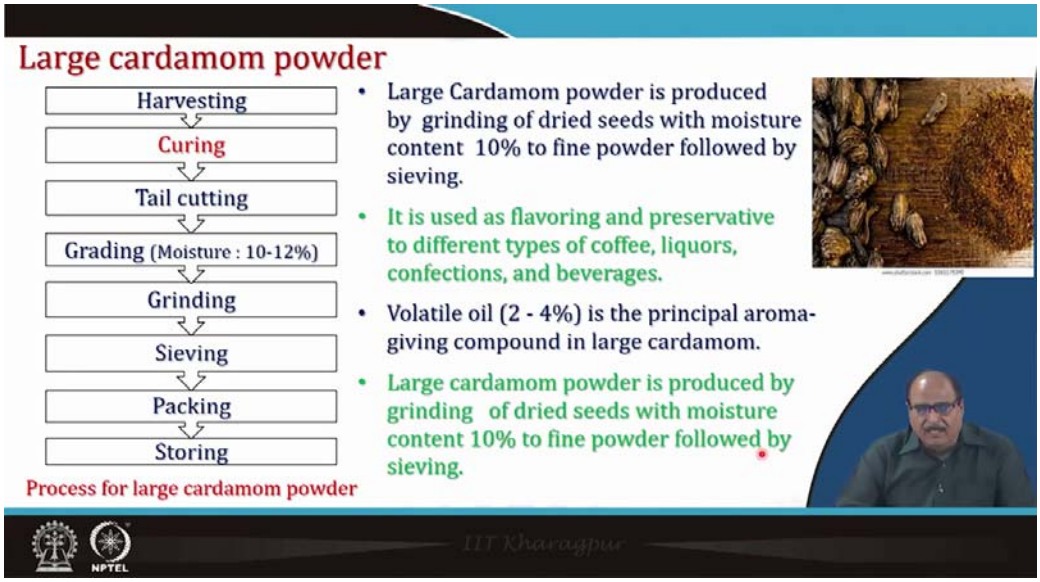


Process for production of turmeric powder

The rhizome is taken, cleaned, cured and cooked, then dried, followed by polishing, grinding, sieving and packaging. Traditionally in India, plate mills or hammer mills are used for grinding making into turmeric powder but attrition mill or pin mill can also be used.

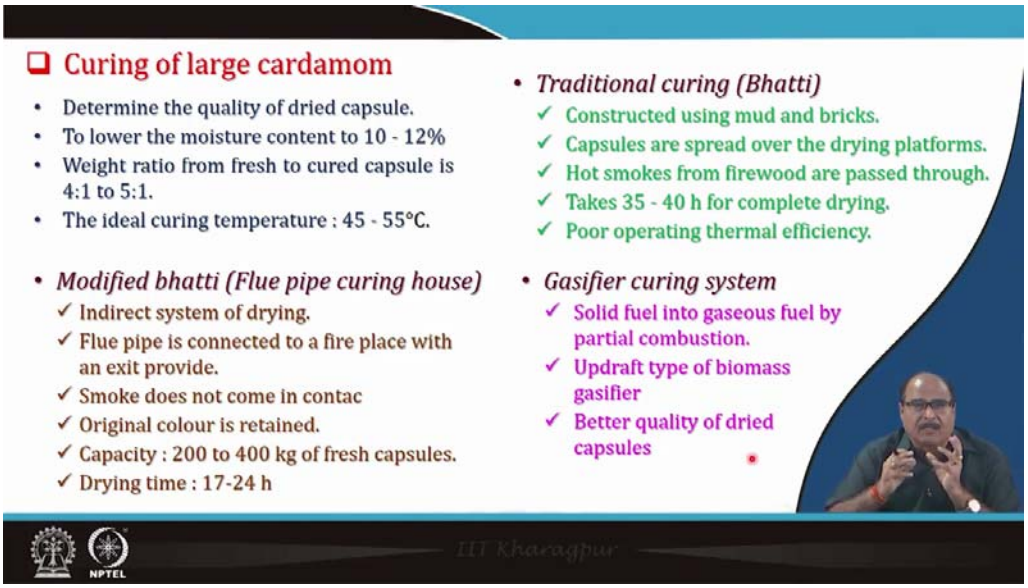
Red chilli powder

The harvested red chillies, well-ripened chilli parts are taken and are kept for 2 to 3 days to develop uniform red colour. Then these are subjected to sun drying or artificial drying; dried to 8 to 10 percent final moisture content. Then these are graded or sorted according to size, weight and colour and dry cleaning is done to remove all the foreign matters that lower the quality and endanger the sale of the commodity. Then stem cutting is done to remove the stem makes crushing easier. Crushing and milling are done in 2-3 rounds of proper grinding to obtain the red chilli powder. After drying, these are grounded to make the powder. Even the vacuum conveyors are used for conveying the chilli powder which is finally, that is the powder water content, moisture content may be up to 8 percent or so. It is finally packed in polyethylene pouches.



Large cardamom powder

Large Cardamom powder is produced by grinding of dried seeds with moisture content 10% to fine powder followed by sieving. It is used as flavoring and preservative to different types of coffee, liquors, confections, and beverages. Volatile oil (2-4%) is the principal aroma-giving compound in large cardamom. Large cardamom powder is produced by grinding of dried seeds with moisture content 10% to fine powder followed by sieving.



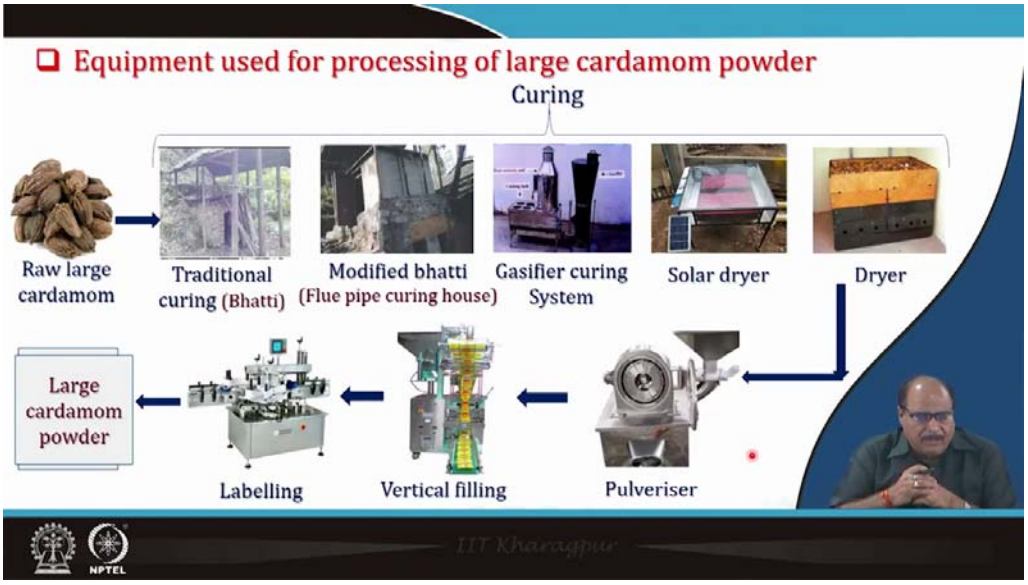
Curing of large cardamom

In the large cardamom, curing is very-very important operation. It determines the quality of the dried capsule. It is done to lower the moisture content to 10 to 12 percent where weight ratio from fresh to cured capsule is around 4:1 to 5:1 and the ideal temperature of the curing is 45 to 55 ˚C so that the proper flavour, volatile oils are produced.

there are traditional curing Bhattis which are constructed using the mud and bricks. The capsules are spread over the drying platform and hot smoke from the firewood are passed through; takes about 35 to 40 hours for complete drying. However, it has a poor operating thermal efficiency.

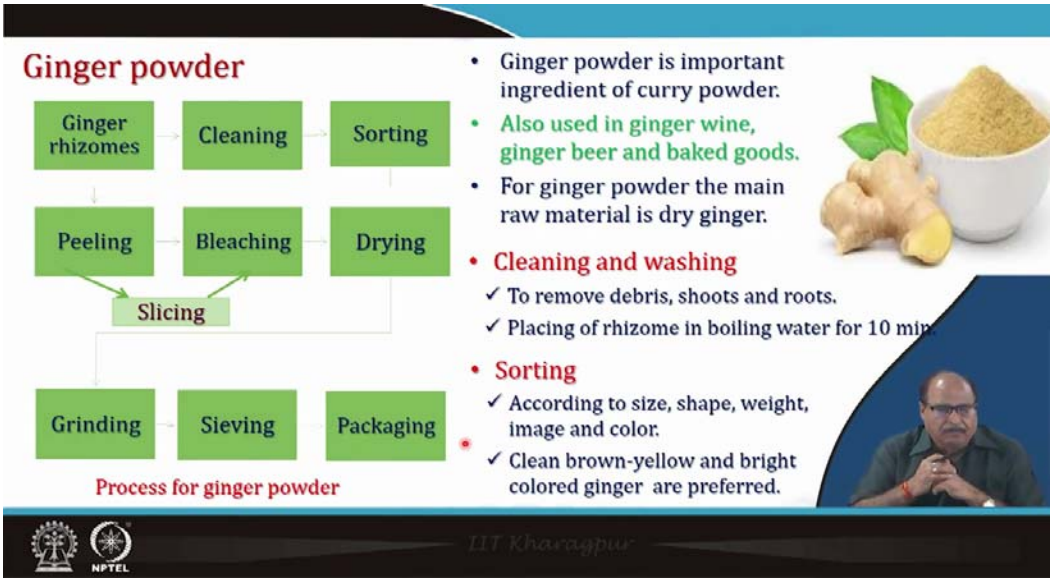
So in some cases, these traditional curing Bhattis are modified with flue pipe curing house. Here indirect system of drying. The flue pipe is connected it to a higher place with the exit provided. Smoke does not come in direct contact. Original flavour, colour is retained and capacity may be 200 to 400 kg of fresh capsules and drying time vary 17 to 24 hours.

And even a gasifier curing system may be used sometime like which is solid fuels into gaseous fuel by partial combustion. It is updraft type of biomass gasifier and it gives a better quality of the dried material.



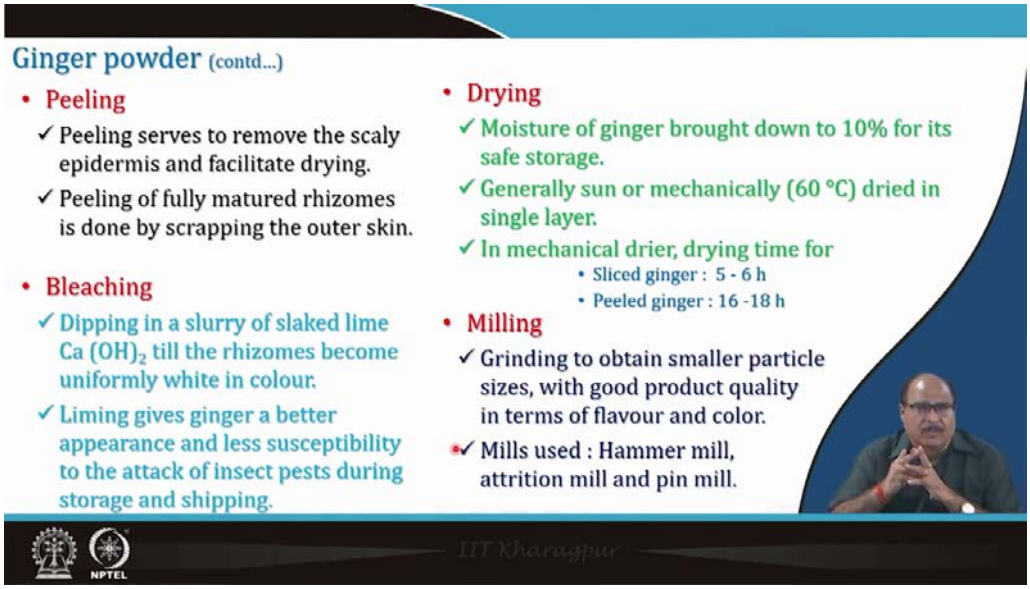
Equipment used for processing of large cardamom powder

So these are the some of the equipment which are used, such as traditional curing Bhatti, modified Bhatti, gasifier system, solar dryer, pulverizer, vertical filling machines.



Ginger powder

Ginger powder is important ingredient of curry powder, also used in ginger wine, ginger beer and baked goods. For ginger powder the main raw material is dry ginger. Cleaning and washing is done to remove debris, shoots, and roots, and placing of rhizome in boiling water for 10 min. These are sorted according to size, shape, weight, image and color. Clean brown-yellow and bright colored ginger are preferred.



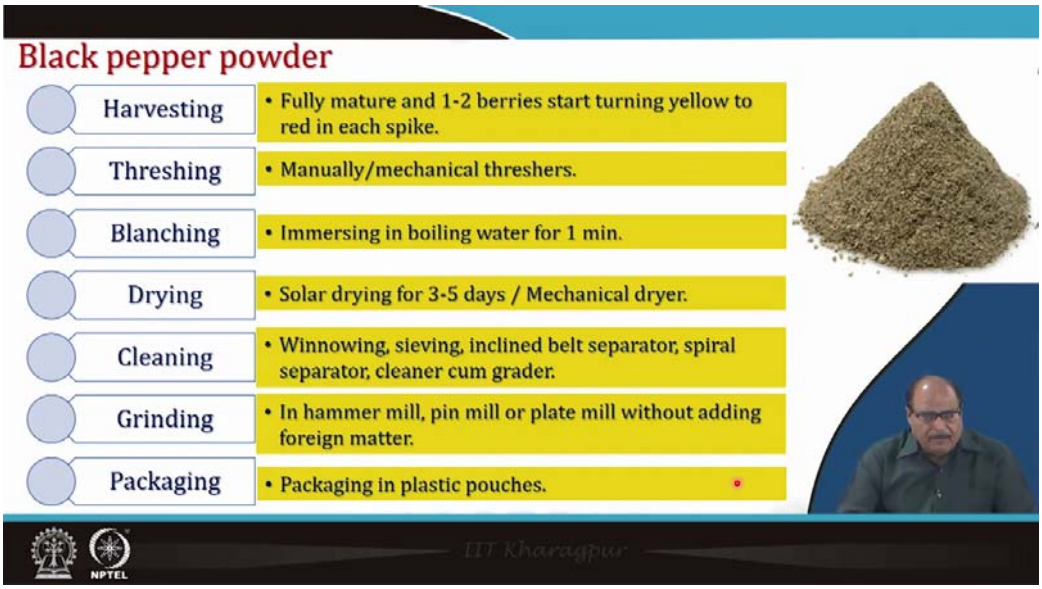
Peeling serves to remove the scaly epidermis and facilitate drying. Peeling of fully matured rhizomes is done by scrapping the outer skin. Dipping in a slurry of slaked lime $Ca(OH)_2$ till the rhizomes become uniformly white in colour. Liming gives ginger a better appearance and less susceptibility to the attack of insect pests during storage and shipping. Then it is dried. This peeled and bleached ginger slices, they are dried to moisture content of 10 percent or so, either sand drying or mechanical drying at around 60 degrees Celsius temperature can be used. And in mechanical drying, the drying time of the sliced ginger is around 5 to 6 hours and the peeled ginger maybe 16 to 18 hours. Then after drying, they are subjected to pulverizing that is milling, grinding to obtain small particle sizes with good product quality in terms of flavour and colour and the hammer mill, attrition mill, or pin mills etc. are used.

Equipment used for production of ginger powder

These are the equipment for making ginger powder as shown in the figure.

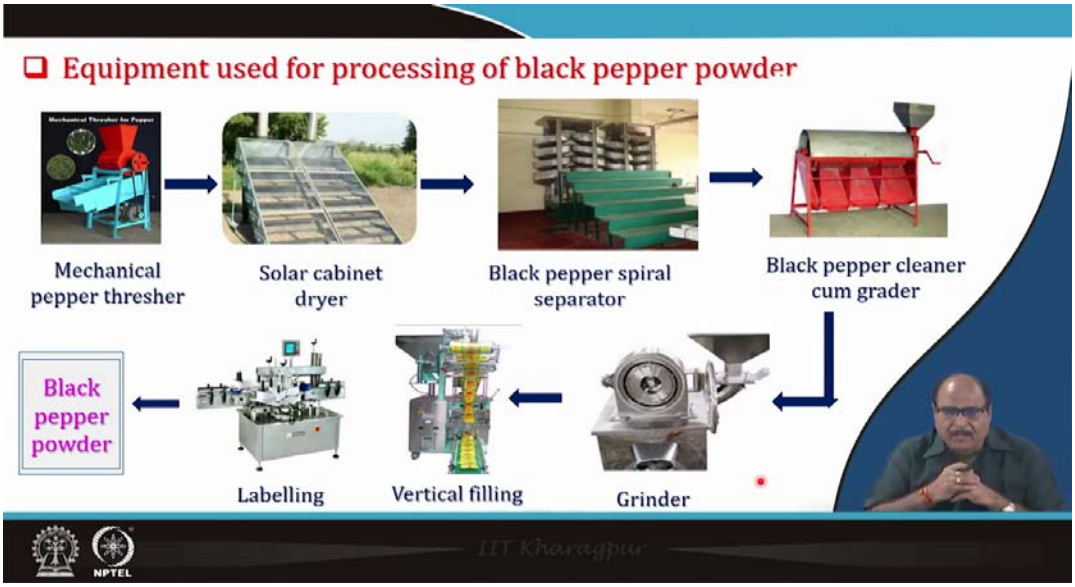
Coriander powder

Seeds are completely dry they begin to detach from the stalk; collected, and grind to obtain the fine powder. Coriander powder is used in seafood, sodas, pickles, bakery, and curry recipes. So the processing operations mainly involved are cleaning, drying, and grinding or pulverizing. So cleaning uses vibro separator, even electronic colour sorters also used to separate discoloured seeds and a gravity separator can also be used. The drying temperature should not exceed more than 100 ˚C as preferable may be 70 ˚C. Solar or mechanical drying, both can be used but traditionally solar drying is used. Grinding is done to a fine powder.



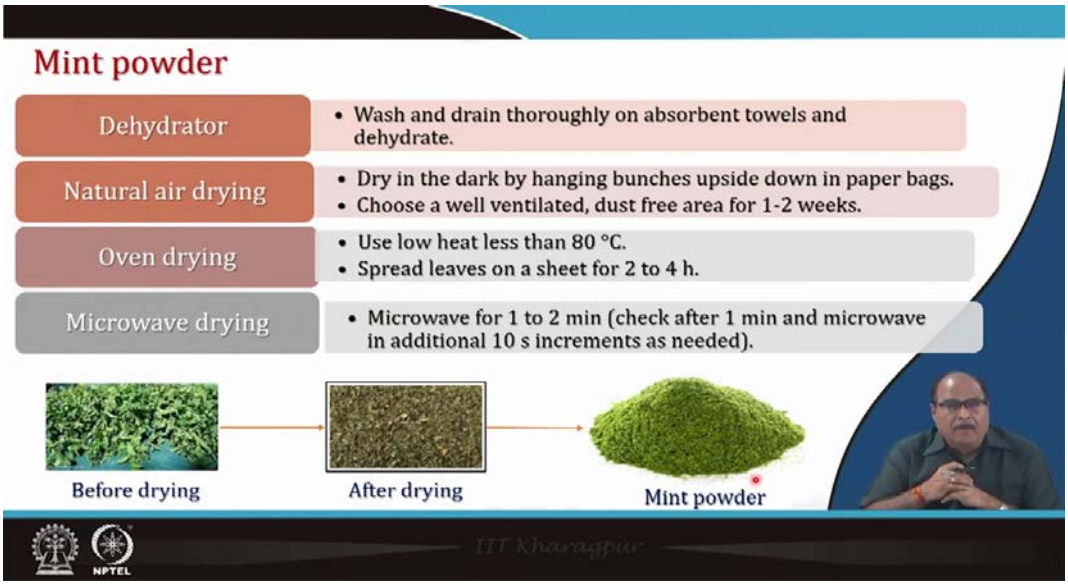
Black pepper powder

Black pepper powder that is harvested as the fully mature black pepper that is 1 to 2 berries start turning yellow to red in each spike. After that is solar dried for 3 to 5 days or mechanical dried and these dried pepper are ground in the hammer mill, pin mill or plate mills, pulverized and packaged suitably.



Equipment used for processing of black pepper powder

Ingredients used for processing of bulk black pepper powder are mechanical pepper thresher, solar cabinet dryer, black pepper spiral separator, black pepper cleaner cum grader, finally grinder and the filling machine, ffs machine and labelling machine.



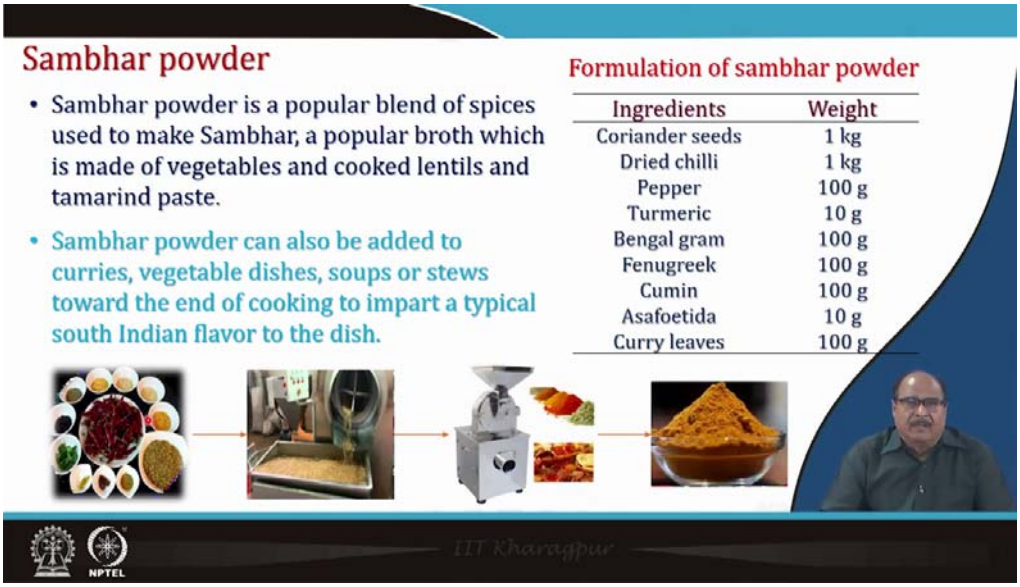
Mint powder

Dehydrator: Wash and drain thoroughly on absorbent towels and dehydrate.

Natural air drying: Dry in the dark by hanging bunches upside down in paper bags. Choose a well ventilated, dust free area for 1-2 weeks.

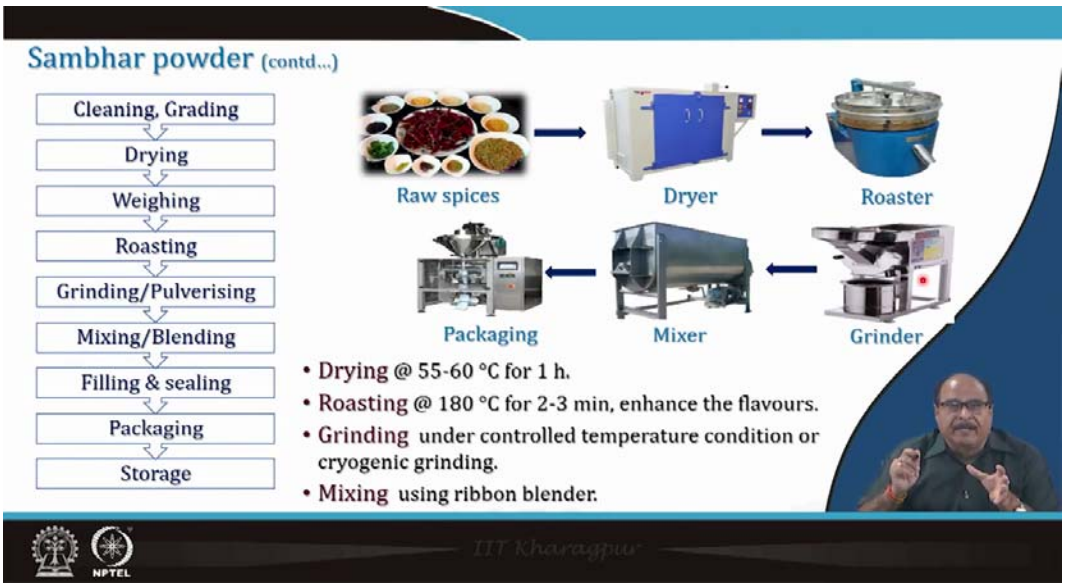
Oven drying: Use low heat less than 80 °C. Spread leaves on a sheet for 2 to 4 h.

Microwave drying: Microwave for 1 to 2 min (check after 1 min and microwave in additional 10 s increments as needed).



Sambhar powder

Sambhar powder is a popular blend of spices used to make Sambhar, a popular broth which is made of vegetables and cooked lentils and tamarind paste. Sambhar powder can also be added to curries, vegetable dishes, soups or stews toward the end of cooking to impart a typical south Indian flavor to the dish. So ingredients for the sambhar powder include coriander seed, dried chilli, pepper, turmeric, Bengal gram, fenugreek, cumin, asafoetida, and curry leaves in the proportion as given here in the table.



So these materials are taken in the appropriate recipe, appropriate quantity spices are taken then these spices are individually dried and then roasted and finally pulverized to the desired size. And after grinding, they are mixed in the proper proportion and sometimes even 2-3 similar spices they can be mixed together in their similar temperatures etc., they can be uniform if their roasting temperature can be of same type so that can also be done but one has to try an experiment with this. And then finally packaging. So generally, drying should be done at 55 to 60 degrees Celsius for 1 hour. Roasting maybe 180 degrees Celsius for 2 to 3

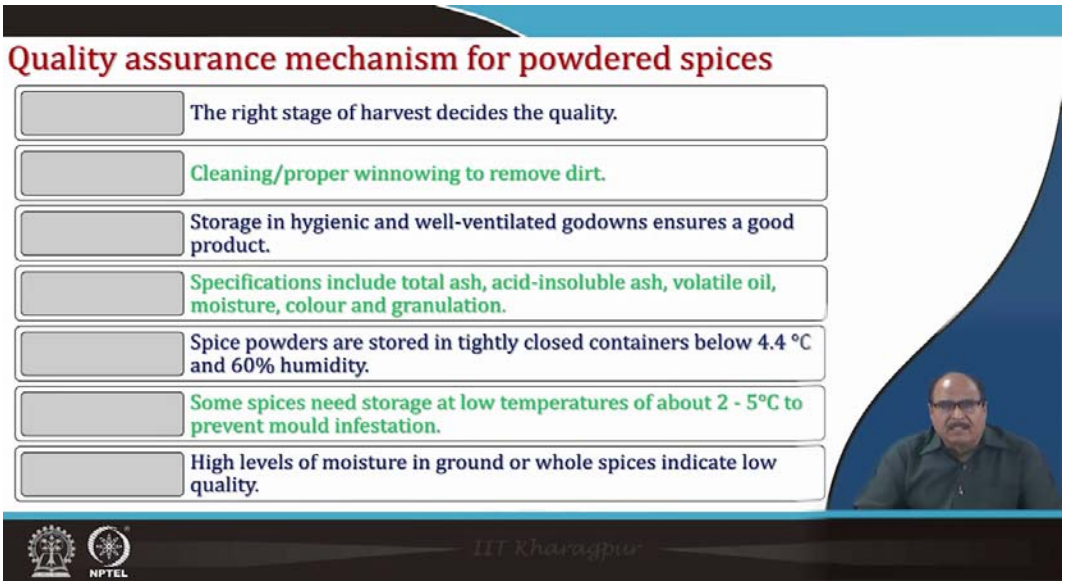
minutes enhances the flavour. Grinding under controlled temperature condition or even cryogenic grinding is recommended. And then mixing using ribbon blender. That is all these ground spices they are mixed. And in fact, the same method that is used for making different masalas in the market. There are various masala- chicken masala, curry masala, curry powder, chole masala, etc. So there all these spices in appropriate quantity, appropriate proportion are roasted and ground masala, they are mixed using ribbon blender or such other blender in appropriate quantity as per the formulation and they are packaged and sold as a specific brand in the masala.

Packaging of spice powder

The packaging of the spice powder is a very important operation. It protects and preserves the spices with a stand-up pouches with nothing locks and gas release valves, tear notches, heavy-duty zipper tops, hang holes, pour sprouts, etc. can be used for sealing the pouches.

And both for the bulk packaging of the spices, paper bags laminated with HDPE woven fabrics on the inner side and inside a liner LDEP or HDPE can be used or even multiwall paper sacks, textile bags, and HDPE woven sacks are used for bulk packaging of the powdered spices.

In the institutional packs, BOPP laminate pouches put into a corrugated box as a territory package. Ground spices packaged in aluminium pouches and paper board cartons can also be used. Even curry powders are placed in the PET jars.

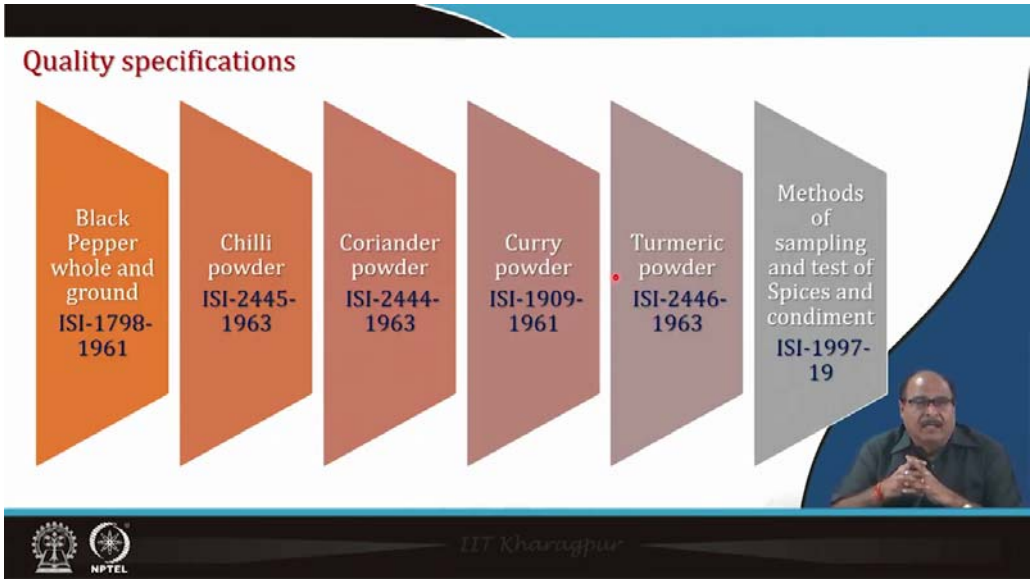


Quality assurance mechanism for powdered spices

Then quality assurance mechanism for the powdered spices that is the right stage of harvest decides the quality. Not only the right stage of the harvest but the appropriate processing and post harvest operation that is cleaning, proper winnowing to remove the dirt, then storage in hygienic and well ventilated godowns. It ensures a good product.

Specifications include both total ash, acid-insoluble ash, volatile oil, moisture content, colour, granulation. So all these are the properties which should be properly there. There are protocols. They should be analysed. It should be ensured that they contain these values.

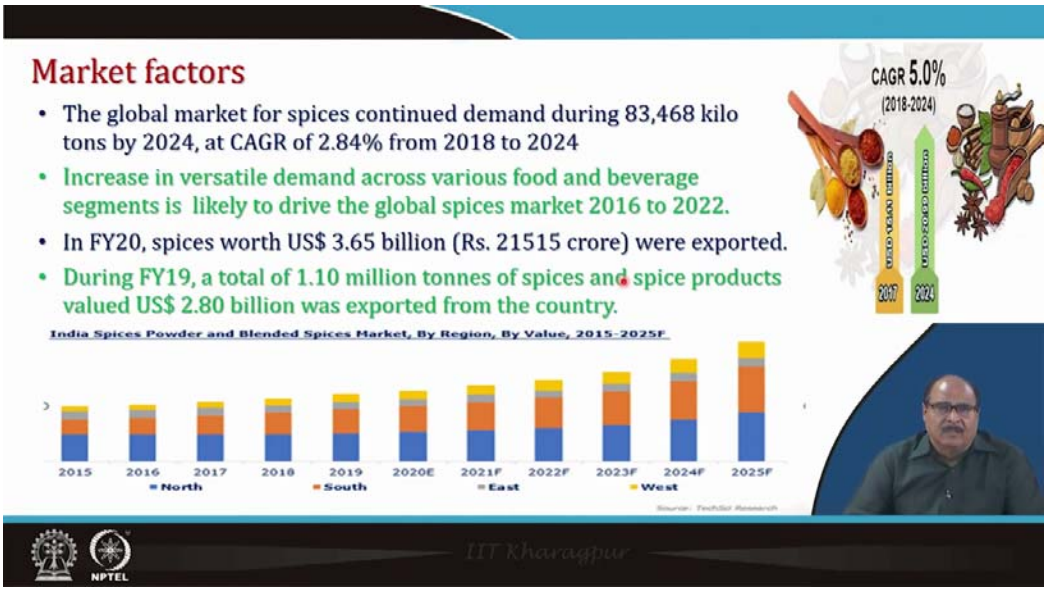
Spice powders are stored in tightly closed container below 4.4 degrees Celsius and 60 percent humidity. Some spices need storage at lower temperature of about 2 to 5 degrees Celsius to prevent mould infestation. Even high levels of moisture in the ground or whole spices indicate or it facilitate or it indicate that low quality because it can facilitate mould or other growth.



Quality specifications

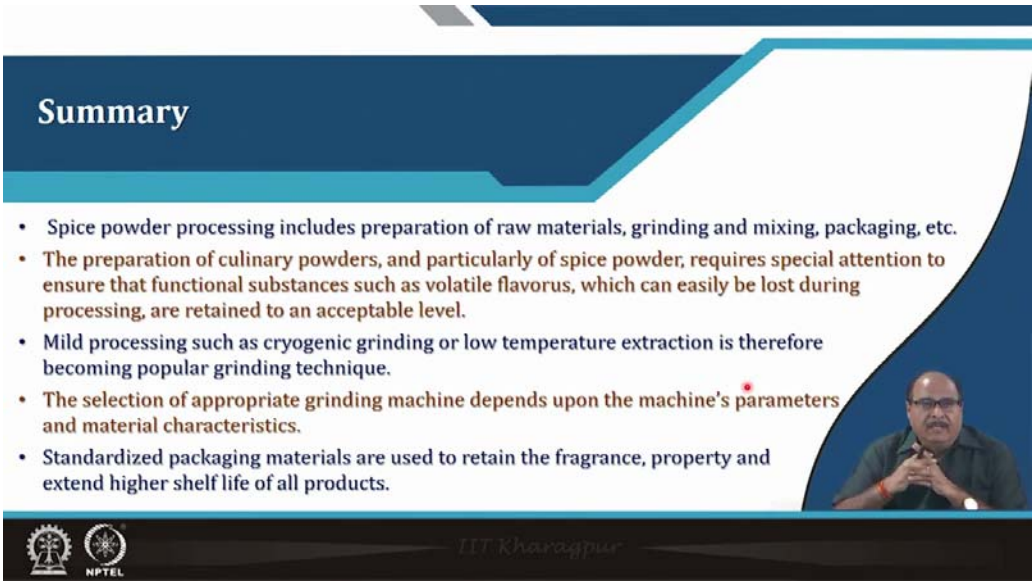
These are for the quality specifications for different spices, are of different grades and in the Bureau of Indian Standards or even FSSAI also has decided like in the ISI-1798 of 1961 can be used to for quality specification for black pepper whole and ground.

Chilli powder, ISI-2445-1963. Coriander powder IS-2444-1963. Curry powder similarly, turmeric powder, they are given a different specification in this. Even there are methods of sampling and test of spices and condiments are provided in the IS-1997-19. So these methods are well regarded, so industry must use this and then must ensure that the spices meet to the quality requirements.

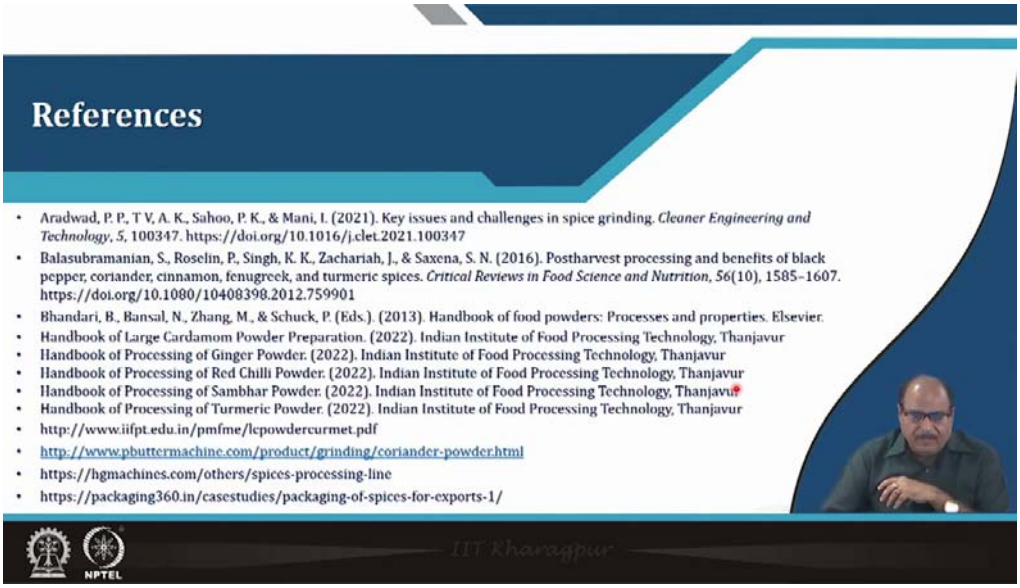


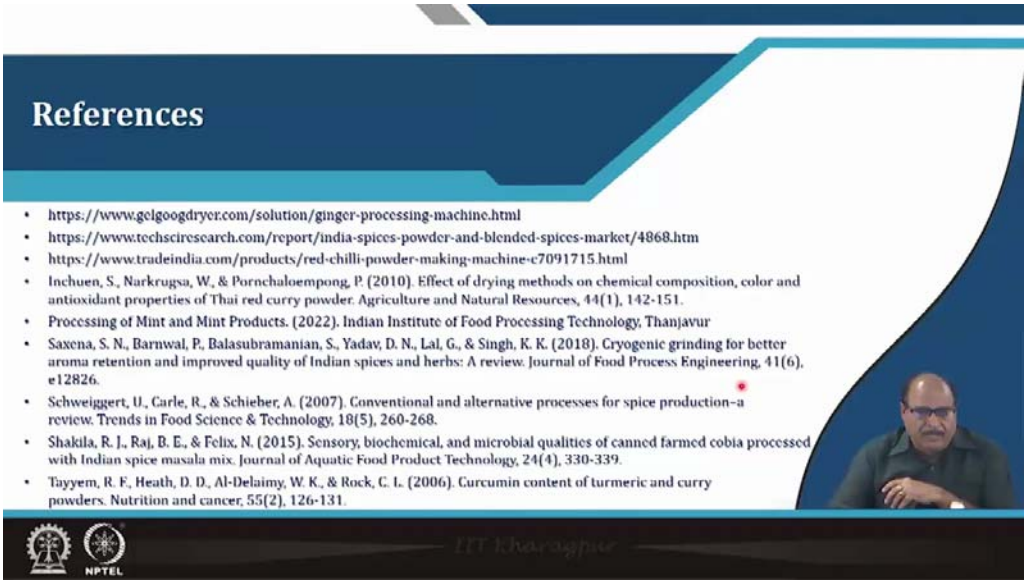
Market factors

The global market for spices continued demand during 83,468 kilo tons by 2024, at CAGR of 2.84% from 2018 to 2024. Increase in versatile demand across various food and beverage segments is likely to drive the global spices market 2016 to 2022. In FY20, spices worth US$ 3.65 billion (Rs. 21515 crore) were exported. During FY19, a total of 1.10 million tonnes of spices and spice products valued US$ 2.80 billion was exported from the country.



In summary, Spice powder processing includes preparation of raw materials, grinding and mixing, packaging, etc. The preparation of culinary powders, and particularly of spice powder, requires special attention to ensure that functional substances such as volatile flavorus, which can easily be lost during processing, are retained to an acceptable level. Mild processing such as cryogenic grinding or low temperature extraction is therefore becoming popular grinding technique. The selection of appropriate grinding machine depends upon the machine's parameters and material characteristics. Standardized packaging materials are used to retain the fragrance, property and extend higher shelf life of all products.





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