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

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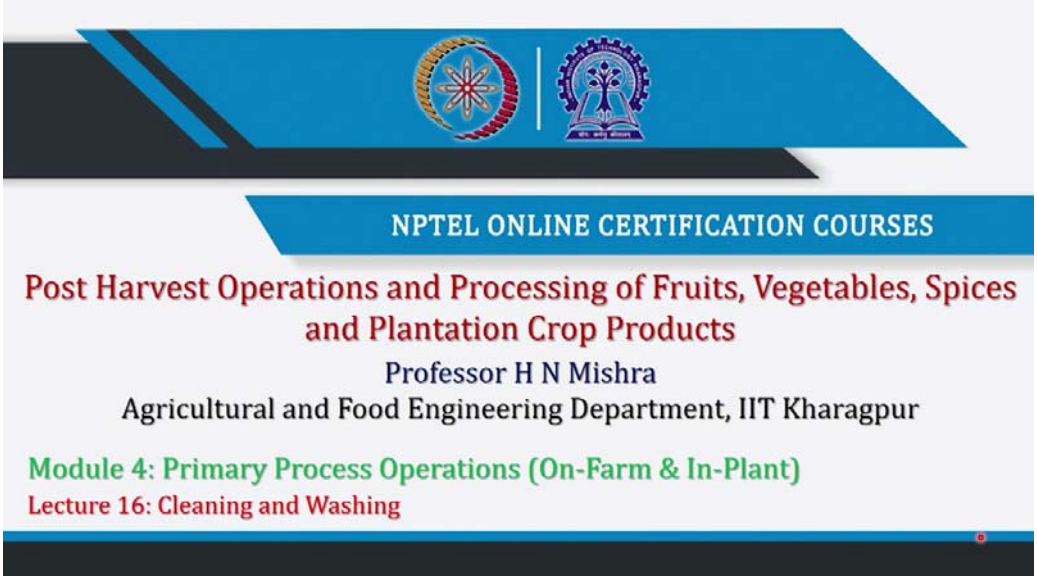
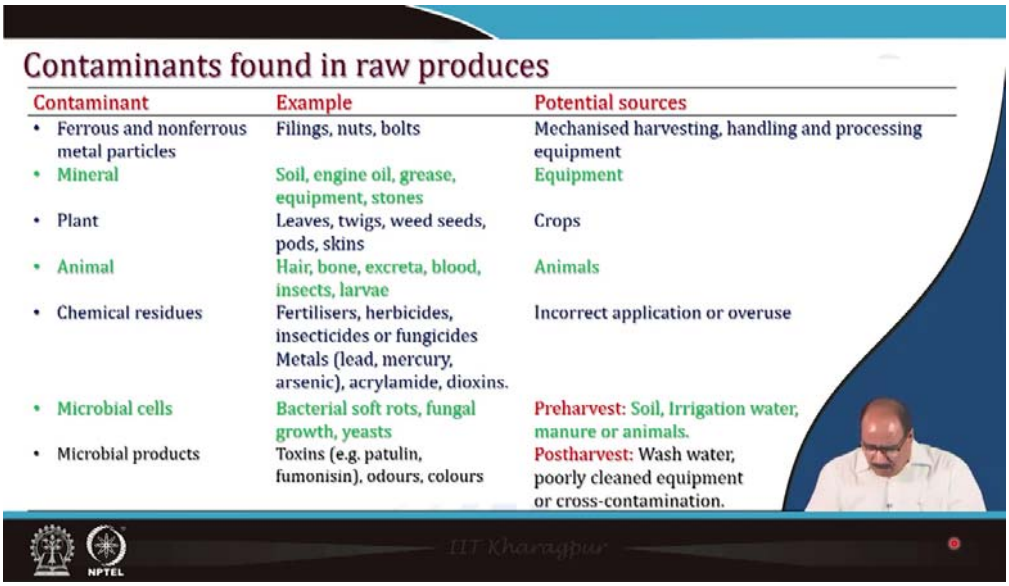
Module 4 Lecture 16
Cleaning and Washing



The topics which will be covered in this lecture include, cleaning and washing of fruits and vegetables, cleaning of spices and condiments, good practices for cleaning and washing operations, cleaning and sanitizing agents, and some of the commonly used cleaning and washing equipment.

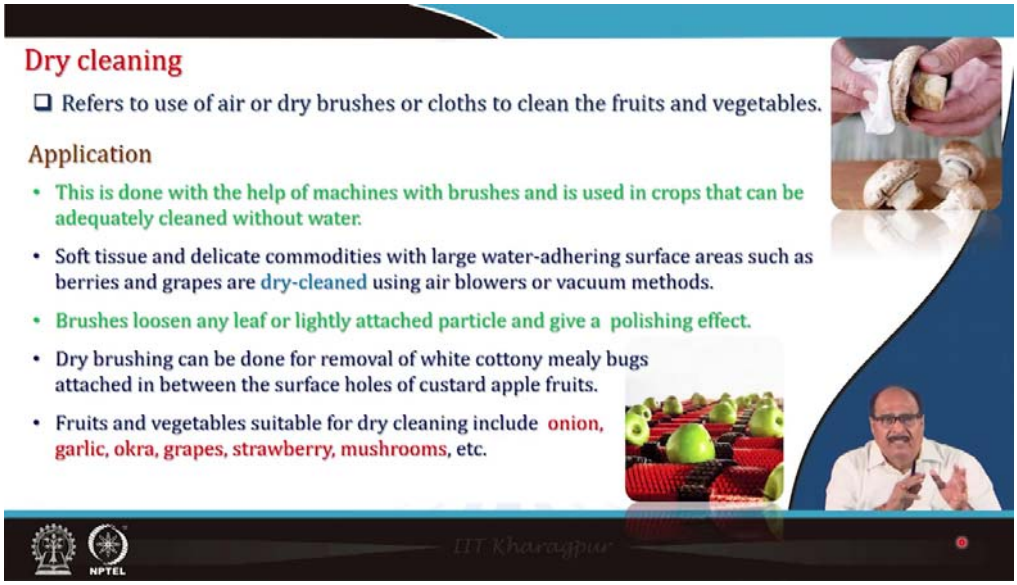
Cleaning is a post-harvest operation of removing foreign impurities such as soil, debris, and any pesticide residues from the horticultural commodity or from a surface, such as utensils and equipment used in handling, processing and storage. It is done either by washing, or by brushing, or some time both washing and brushing are used.

It is an important operation because it improves appearance of the commodity, it helps in maintaining the quality of the produce, and also increases the shelf-life. Various methods of cleaning fruits and vegetables include dry cleaning, trimming, wet cleaning, etc.

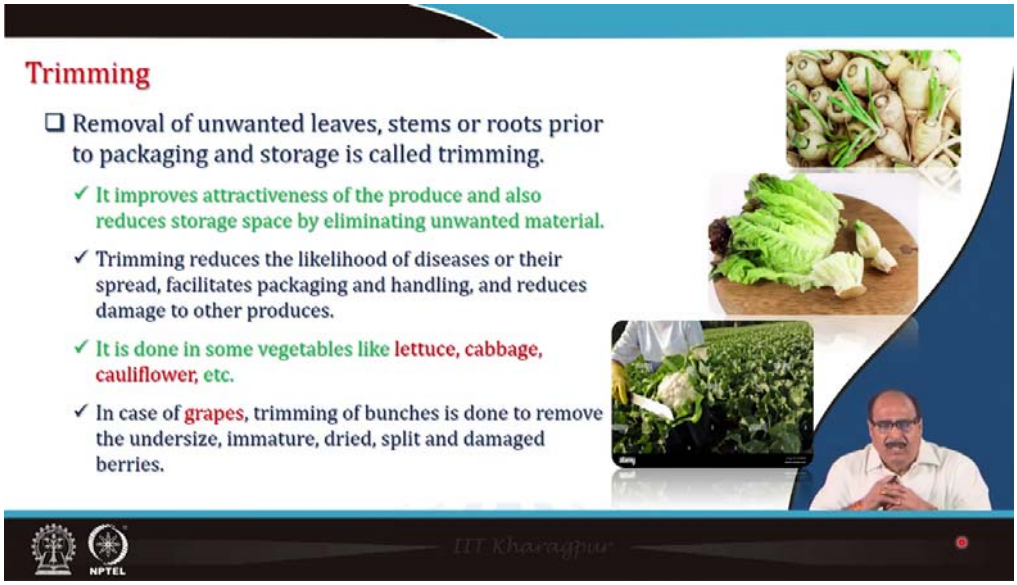


In this table enlists different contaminants which are found in the raw horticultural produces. The contaminants such as ferrous and nonferrous metal particles (e.g. filings, nuts, bolts) are produced after mechanical harvesting, and found in handling and processing equipment. Similarly, even the leaves, twigs, seed, or weeds, pods, skins of other plants may come from various plant sources, or different crops in the field. Hairs, bones, excreta, blood, insects, larvae may come from the various animals. Other common contaminants are bacterial soft

rot, fungal growth, yeast, or various toxin produced by the microorganisms, which are found in different products.

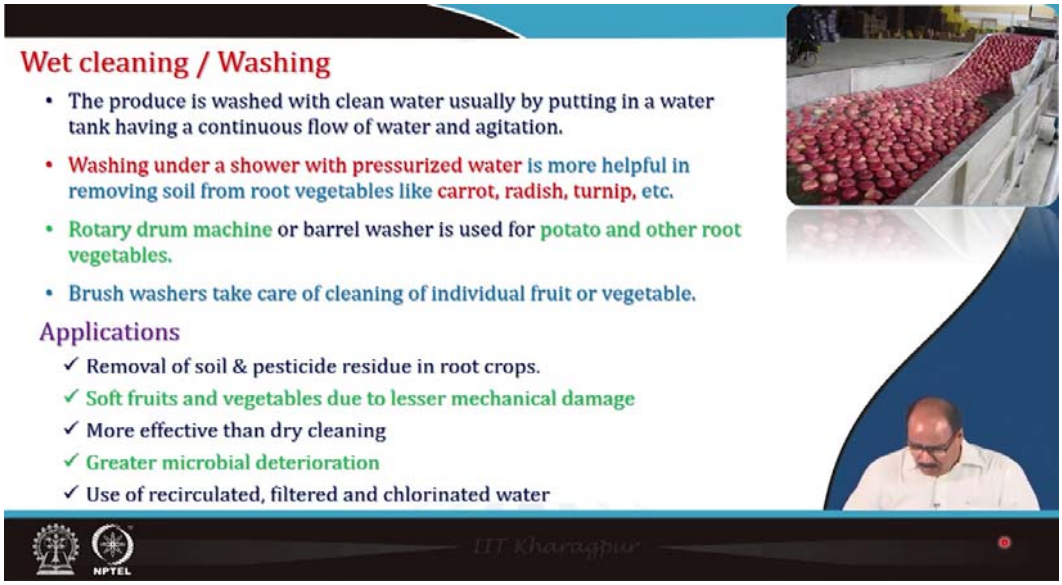


Dry cleaning, refers to the use of air, or dry brushes, or cloths to clean the fruit and vegetables. This is done with the help of machines which are fitted with brushes, and is used in crops that can be adequately cleaned without water. Soft tissues and delicate commodities with large water-adhering surfaces areas such as berries and grapes are generally dry-cleaned using air blowers or vacuum methods. Brushes loosen any leaf or lightly attached particles and give a polishing effect. Dry brushing can be done for removal of white cottony mealy bugs attached in between the surfaces holes of the custard apple fruits. The fruits and vegetables, which are generally suitable for dry cleaning include onion, garlic, okra, grapes, strawberry, mushroom, etc.



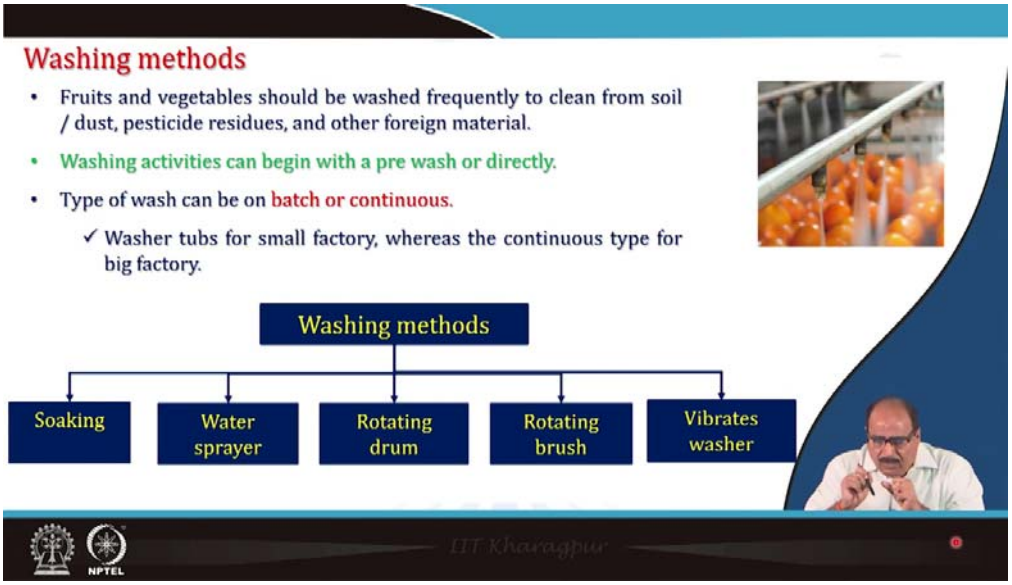
Trimming is the removal of the unwanted leaves, stems or roots prior to their packaging and storage. It improves attractiveness of the produce, and also reduces storage space by eliminating the unwanted materials. Trimming reduces the likelihood of disease or their

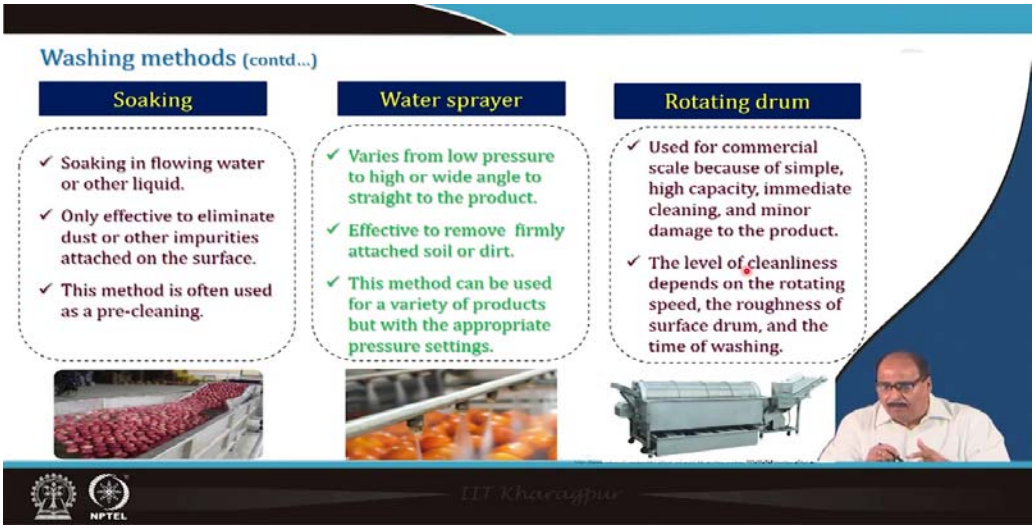
spread, facilitating packaging and handling and reduces damages to other products. It is done in some vegetables like lettuce, cabbage, cauliflower etc. In case of grapes, trimming of bunches is done to remove the undersize, immature, dried, split and damaged berries.



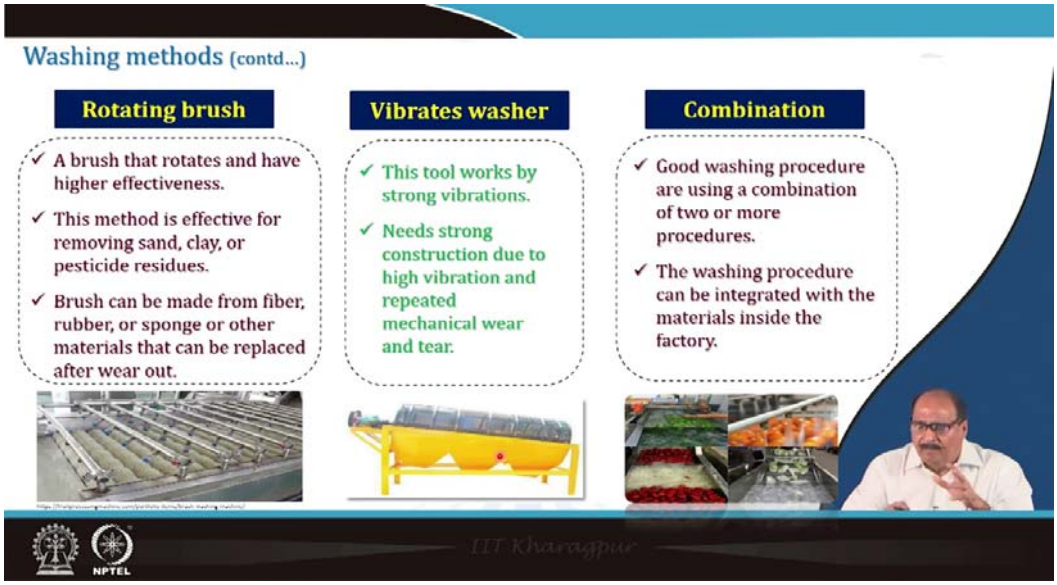
In wet cleaning, or washing, the produce is washed with clean water usually by putting in a water tank having a continuous flow of water and agitation. Washing under a shower with pressurized water is more helpful in removing the soil from the root vegetables like carrot, radish, turnip, etc. Rotary drum machines, or barrel washers is used for potato and other root vegetables. Brush washers take care of cleaning of individual fruits or vegetables. So, wet cleaning or washing applications may be done to remove soil and pesticide residues in the root crops, soft fruits and vegetables due to lesser mechanical damage. It is more effective than dry cleaning, because less damage is here and better cleaning is there. It causes greater microbial deterioration. In this the deterioration, or removal of the microorganism, microbial contamination is more here in the case of wet cleaning, then in comparison to that of the dry cleaning. Use of recirculated, filtered, and chlorinated water is to ensure that the cleaning is proper.

The washing can be done either batch wise, or in continuous manner. So, generally in the small factory, washers tubs are used. Whereas, in the big factories, continuous type washing systems are used. The different washing methods commonly used are soaking, water sprayer, rotating drum, rotating brush, and vibrate washers.





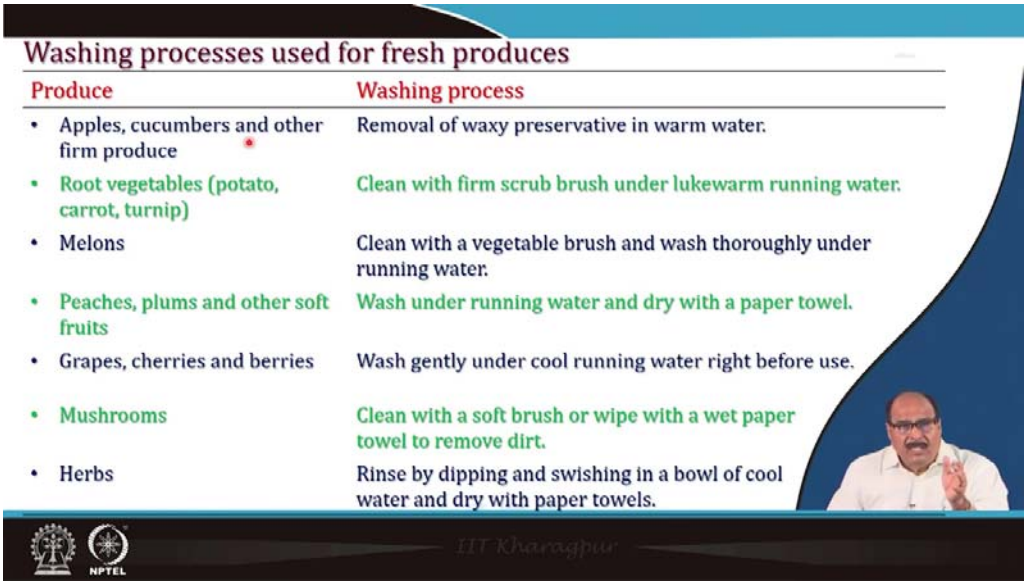
In the soaking method, the flowing water or other liquid, are used for soaking of commodities. It is only effective to eliminate dust, or other impurities which are attached on the surface of the produce. This method is often used as a pre-cleaning operation. Water sprayer varies from low pressure to high, or wide angle to straight to the product. It is effective to remove firmly attached soil or dirt. This method can be used for a variety of products but with appropriate pressure settings. The rotating drum are used for commercial scale because of simple, high capacity, and immediate cleaning, and minor damage to the product. The level of cleanliness depends upon the rotating drum speed, the roughness of the surface drum, and the time of washing.



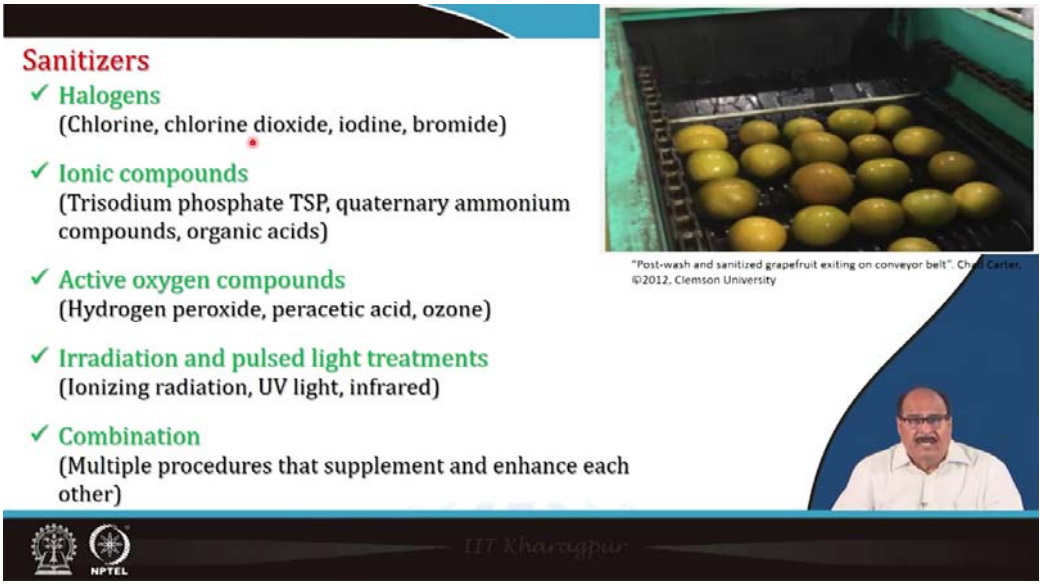
In the rotating brush system, a brush that rotates, and have higher effectiveness. This method is effective for removing sand, clay, or pesticide residues. Brush can be made from fiber, rubber, or sponge, or other materials that can be replaced after wear out. Vibrates washer works by the strong vibration, which needs strong construction due to high vibration, and repeated mechanical wear and tear. So, it is a good practice by the industry to follow a combination of these methods. So, good washing procedures are using a combination of two or more procedures, the washing procedures can be integrated with the materials inside the factory.

The roller with brush cleaning machine consists of a roller with brush washing (cleaning) system. It is made up of stainless steel tube and brush. The brush is made of polyethylene, and will make revolution as the movement of stainless steel chain. Fruits are driven to circumvolve and washed by brush. At the same time, the bad or rejected fruits are picked up manually and then sent away by scrap conveying device. It can be used for washing and

cleaning of root vegetables and tubers such as taro, sweet potato, radish, carrot, potato, ginger, etc. That is mostly the root vegetables and tubers.

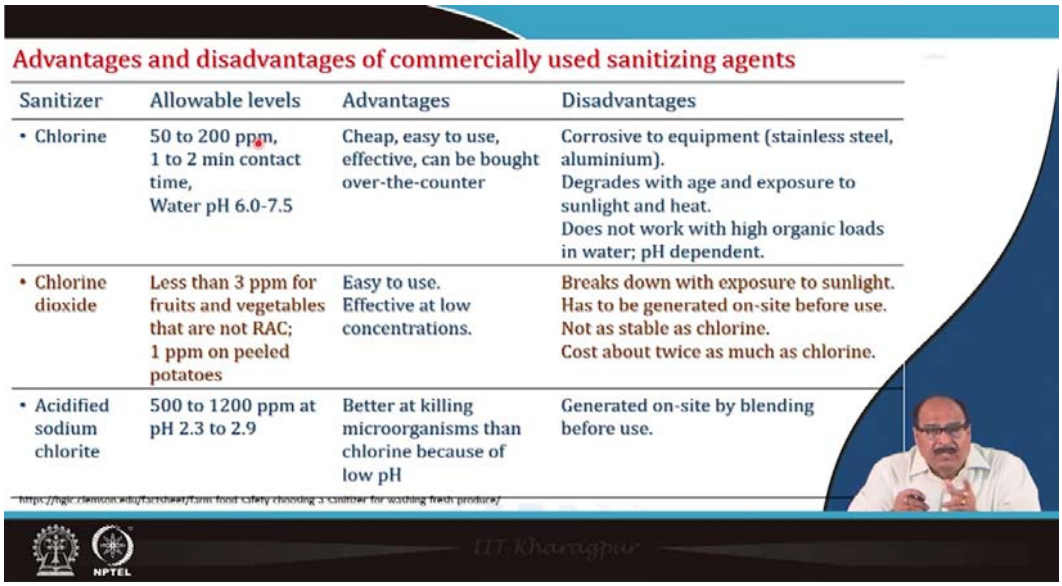


The washing processes which are used for the fresh produces like, apple, cucumbers, and other firm produces requires the removal of waxy preservative in warm water. In the root vegetable like potato, carrot, turnips, these are cleaned with firm scrub brush, under lukewarm running water. Fruits like melons are cleaned with a vegetable brush, and washed thoroughly under the running water. Fruits like peaches, plums, and other soft fruits, these are washed under running water, and dried with a paper towel. Grapes, cherries, and berries are washed gently under cold running water, right before their use. Mushrooms are cleaned with a soft brush, or wipe with a soft wet paper towel to remove the dirt. Herbs are rinsed by dipping and swishing in a bowl of cool water, and a dry with paper towels.



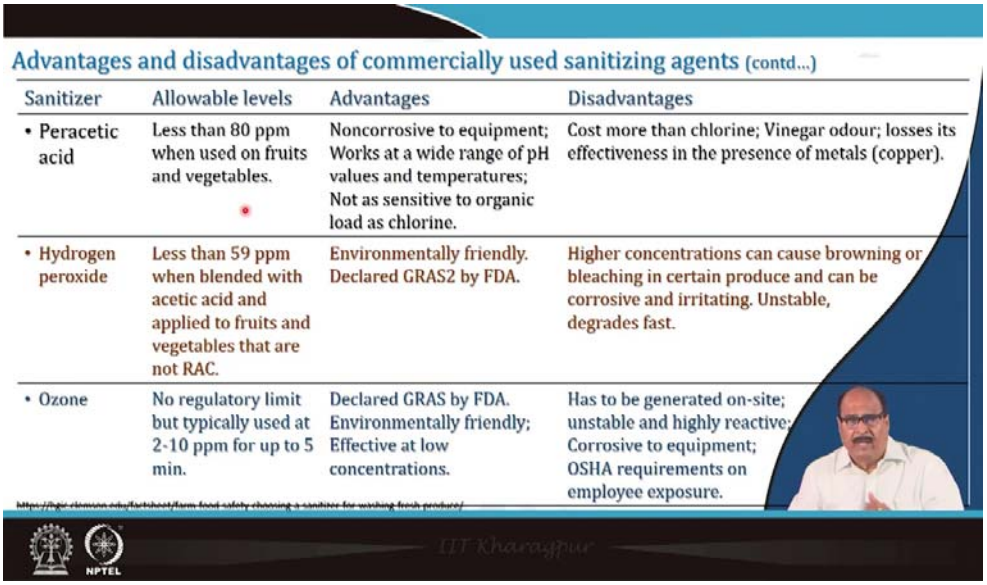
The fruits and vegetables because of their proximity to the soil, in the root, tubers, they might be associated with various microbial contaminants, thus, it becomes very important to sanitize these commodities. So, along with the washing water, some sanitizers are added. The

commonly used sanitizers include halogens (chlorine, chlorine dioxide, iodine, bromide), ionic compounds (trisodium phosphate, quaternary ammonium compounds), active oxygen compounds (hydrogen peroxide, peracetic acid, ozone), irradiation and pulsed light treatments (ionizing radiation, ultraviolet light, infrared light), and combination of multiple procedures that supplement and enhance each other's effectiveness.

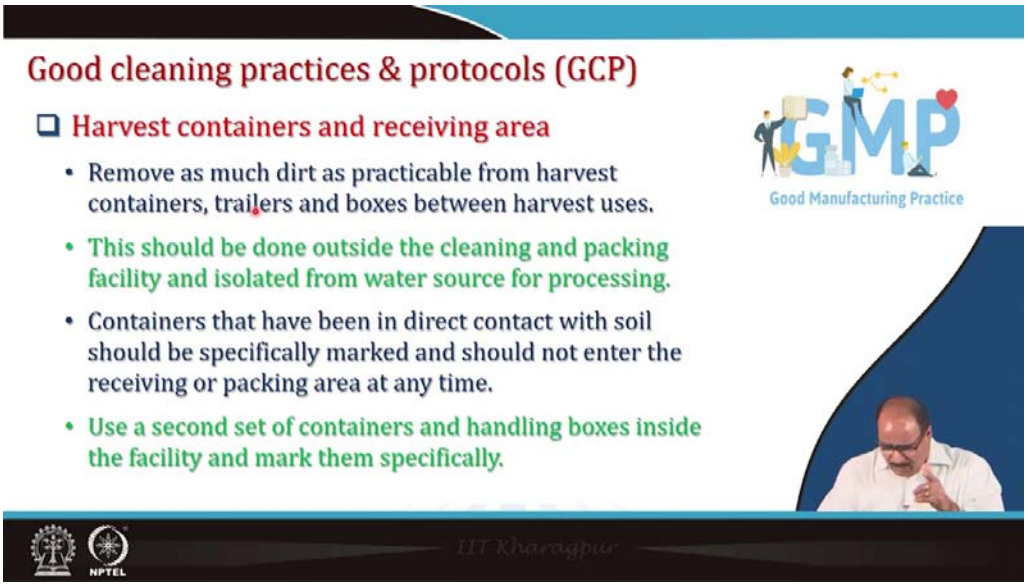


Advantages and disadvantages of commercially used sanitizing agents

The allowable levels of chlorine are 50 to 200 ppm, 1 to 2 min contact time, and the pH of water should be 6.0-7.5. The advantages of this sanitizing agent are cheaper, easy to use, effective, can be bought over-the-counter. This is corrosive to equipment (stainless steel, aluminium), degrades with age and exposure to sunlight and heat, does not work with high organic loads in water; and pH dependent. Similarly, less than 3 ppm of chlorine oxide is recommended for fruits and vegetables, and 1 ppm on peeled potatoes. It is easy to use and effective at low concentrations. The disadvantages include breaking down with exposure to sunlight, has to be generated on-site before use, not as stable as chlorine, and cost is about twice as much as chlorine. The desired level of acidified sodium chlorite is 500-1200 ppm at pH 2.3 to 2.9, and it is better at killing microorganisms than chlorine because of low pH as well as it is generated on-site by blending before use.

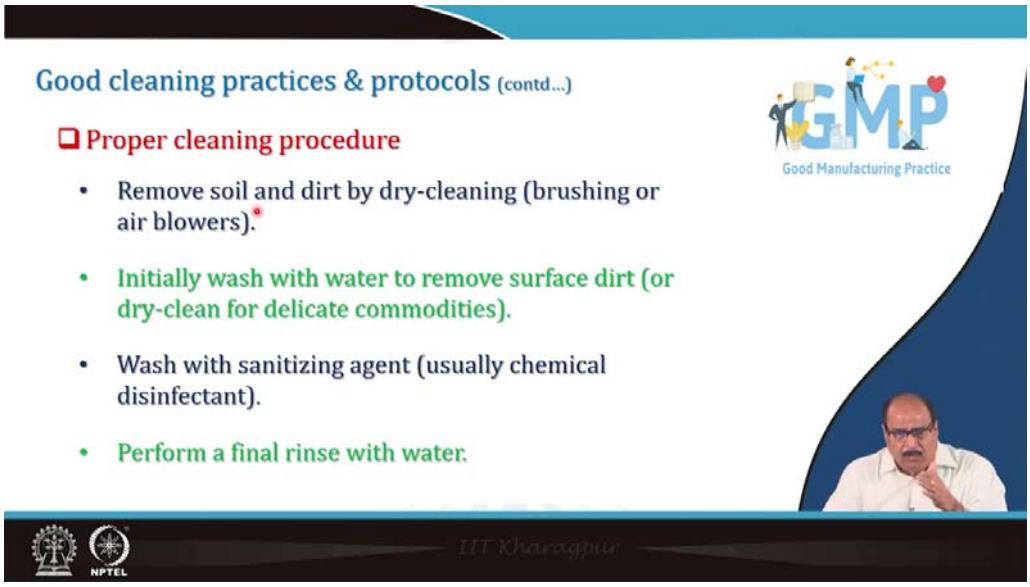


For peracetic acid, the recommended level is less than 80 ppm when used on fruits and vegetables, it is noncorrosive to equipment, works at a wide range of pH values and temperature. And it is not as sensitive to organic load as chlorine. However, its cost is more than the chlorine. The allowable level of hydrogen peroxide is less than 59 ppm, when blended with acetic acid, and applied to fruits and vegetables that are not RAC. It is environmentally friendly and has been declared as GRAS2 by FDA. Higher concentrations can cause browning, or bleaching in certain products, and can be corrosive and irritating. It is unstable and degrades fast. There are no regulatory limits or levels for ozone, but typically it is used at 2 to 10 ppm for up to 5 minutes, it is declared GRAS by FDA. It is also environmental friendly, effective at low concentration, but it has to be generated on-site. It is unstable for highly reactive, corrosive to equipment, and OSHA requirements on employee exposure.

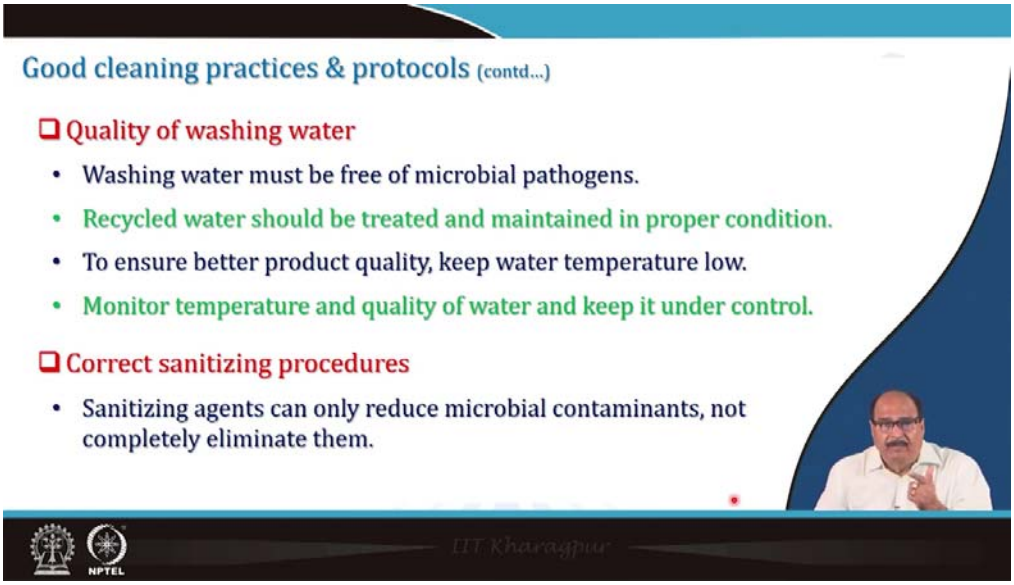


Good cleaning practices and protocols (GCP) has to be followed at each and every stage of cleaning. For example, in harvest containers and receiving areas, remove as much as dirt as

possible from the harvest containers, trailers, and boxes between the harvest uses. This should be done outside the cleaning and packing facility, and isolated from water source for processing. Containers that have been in direct contact with soil, should be specifically marked, and should not be allowed to enter the receiving or packaging area at any time. Use a second set of containers and handling boxes inside the facility, mark them especially to be used inside the facility.

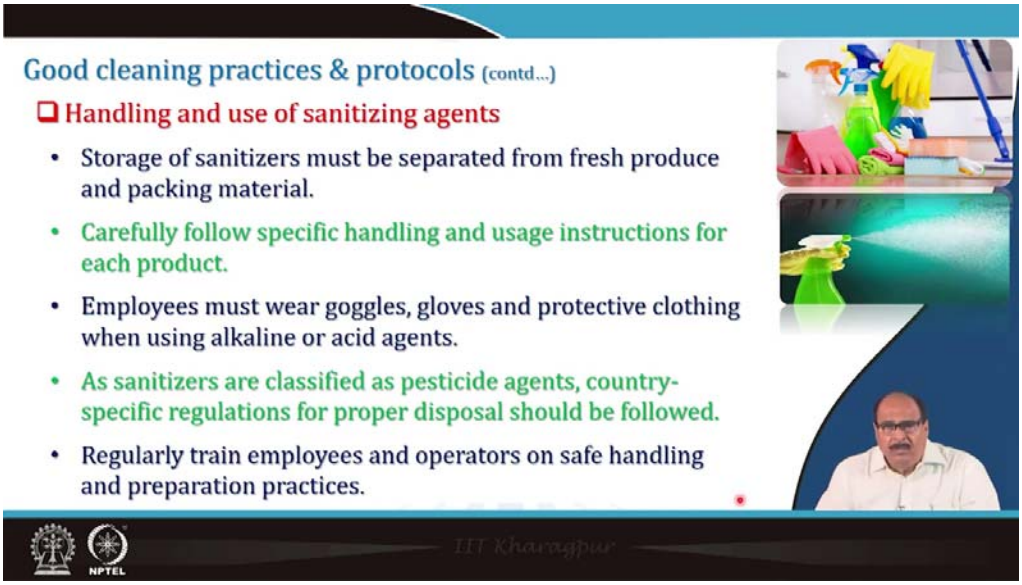


Proper cleaning procedure is to be followed, which should be efficient and effective to remove soil and dirt by dry cleaning, brushing, or air blower. Initially wash with water to remove surface dirt, or dry-clean for delicate commodities. Wash with sanitizing agent, usually chemical disinfectant etcetera. And then, perform a final rinse with the water.

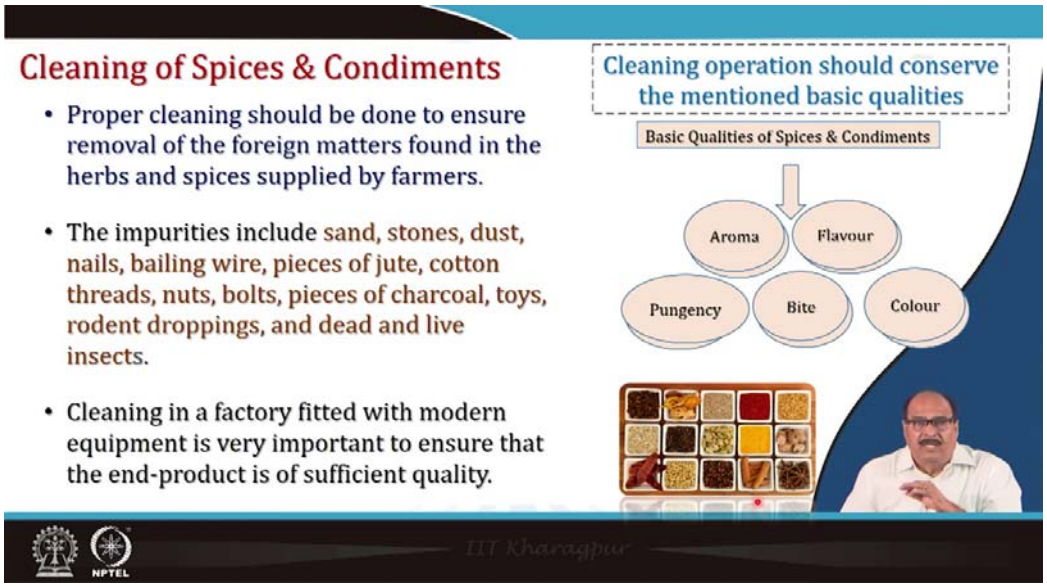


Quality of the washing water is again an important aspect. Washing water must be free from microbial pathogens. Recycled water should be treated, and maintained in proper condition. To ensure better product quality, keep water temperature as low as possible. Monitor the treatment and quality of the water, and keep it under control. The sanitizing agents which are

used should be effective to reduce the microbial contamination, but not completely eliminate them.

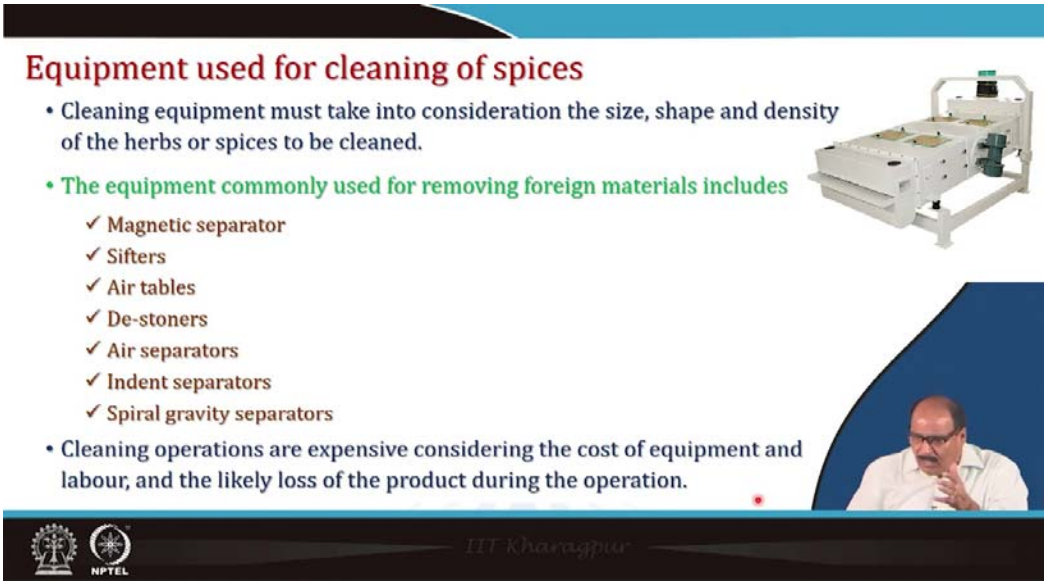


Storage of sanitizers must be separated from fresh produce and packing material. Carefully follow specific handling and usage instructions for each product. Employees must wear goggles, gloves and protective clothing when using alkaline or acid agents. As sanitizers are classified as pesticide agents, country-specific regulations for proper disposal should be followed. Regularly train employees and operators on safe handling and preparation practices.

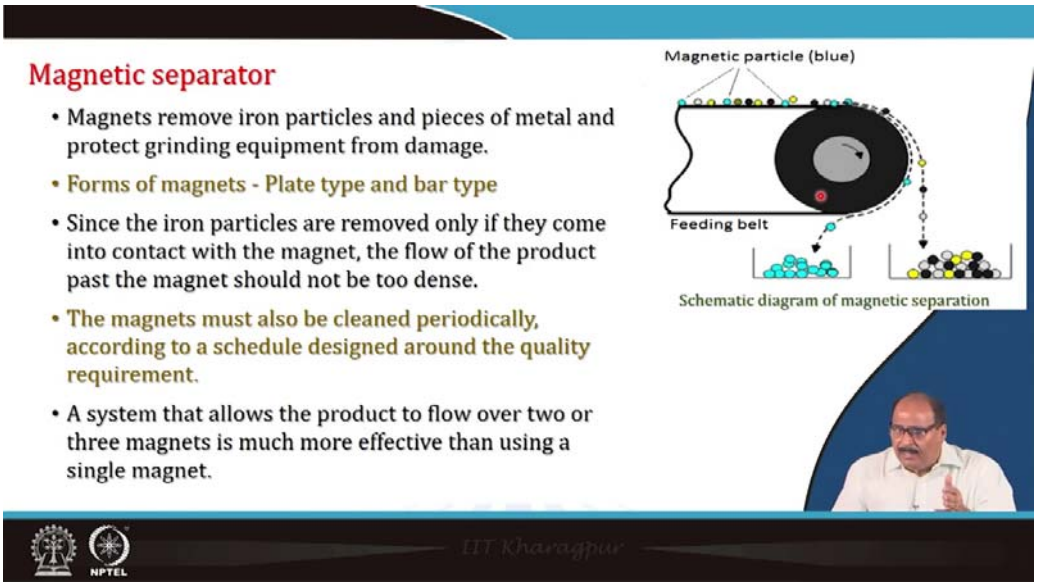


Proper cleaning of spices and condiments should be done to ensure removal of the foreign matters found in the herbs and spices supplied by farmers. The impurities include sand, stones, dust, nails, bailing wire, pieces of jute, cotton threads, nuts, bolts, pieces of charcoal, toys, rodent droppings, and dead and live insects. Cleaning in a factory fitted with modern equipment is very important to ensure that the end-product is of sufficient quality. Cleaning

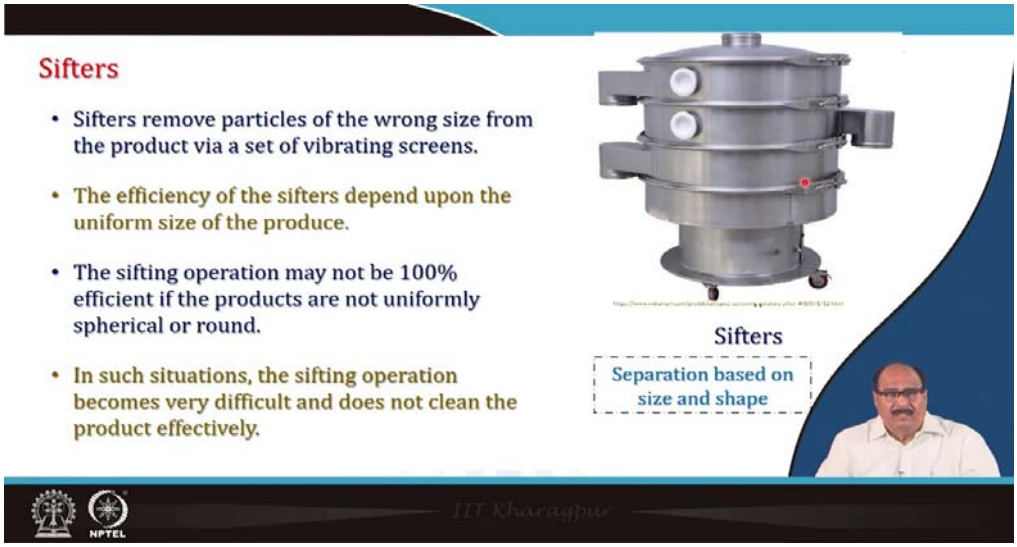
operation should conserve the mentioned basic qualities such as aroma, flavour, pungency, bite, and colour.



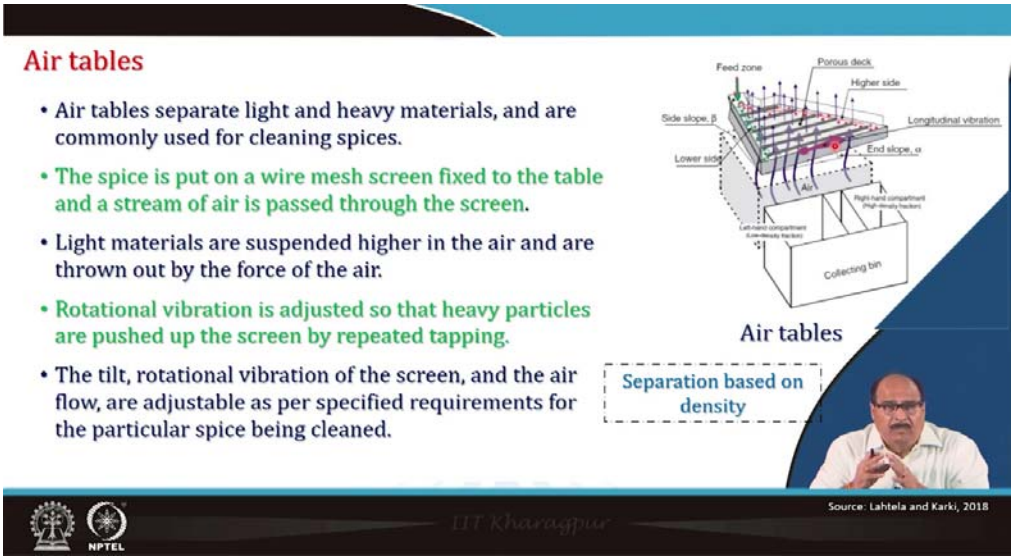
Cleaning equipment must take into consideration the size, shape and density of the herbs or spices to be cleaned. The equipment commonly used for removing foreign materials includes magnetic separator, sifters, air tables, de-stoners, air separators, indent separators, spiral gravity separators. Cleaning operations are expensive considering the cost of equipment and labour, and the likely loss of the product during the operation.



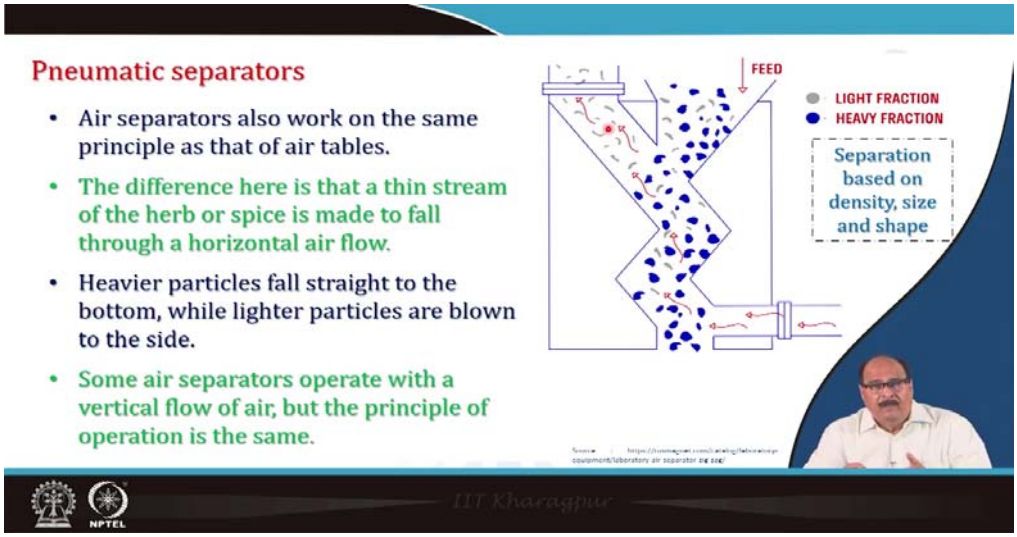
In magnetic separator, magnets remove iron particles and pieces of metal and protect grinding equipment from damage. The forms of the magnet may be plate type, or bar type. Since the iron particles are removed only if they come into contact with the magnet, the flow of the product past the magnet should not be too dense. The magnets must also be cleaned periodically, according to a schedule designed around the quality requirement. A system that allows the product to flow over two or three magnets is much more effective than using a single magnet.



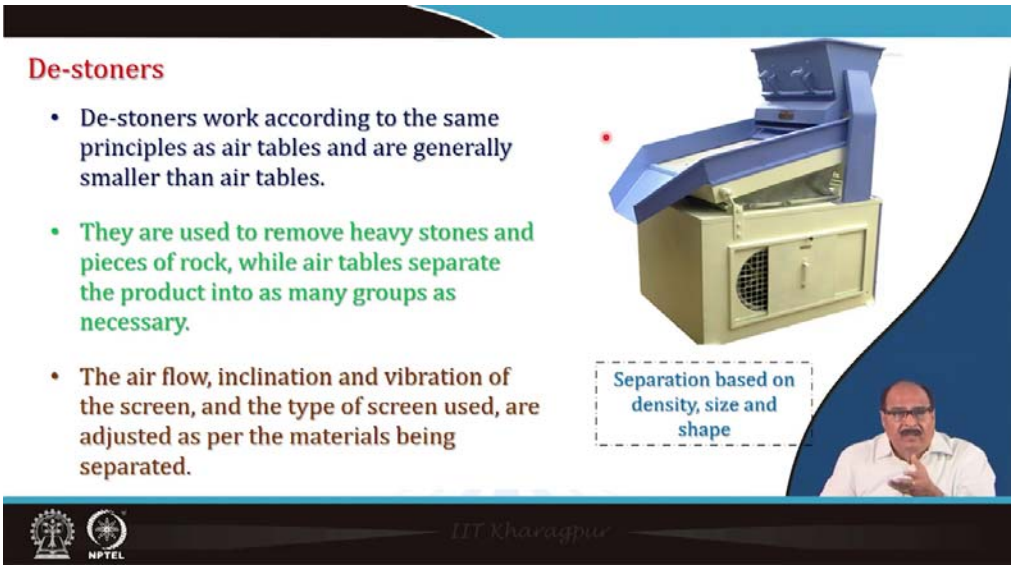
Sifters remove particles of the wrong size from the product via a set of vibrating screens. The efficiency of the sifters depend upon the uniform size of the produce. The sifting operation may not be 100% efficient if the products are not uniformly spherical or round. In such situations, the sifting operation becomes very difficult and does not clean the product effectively.



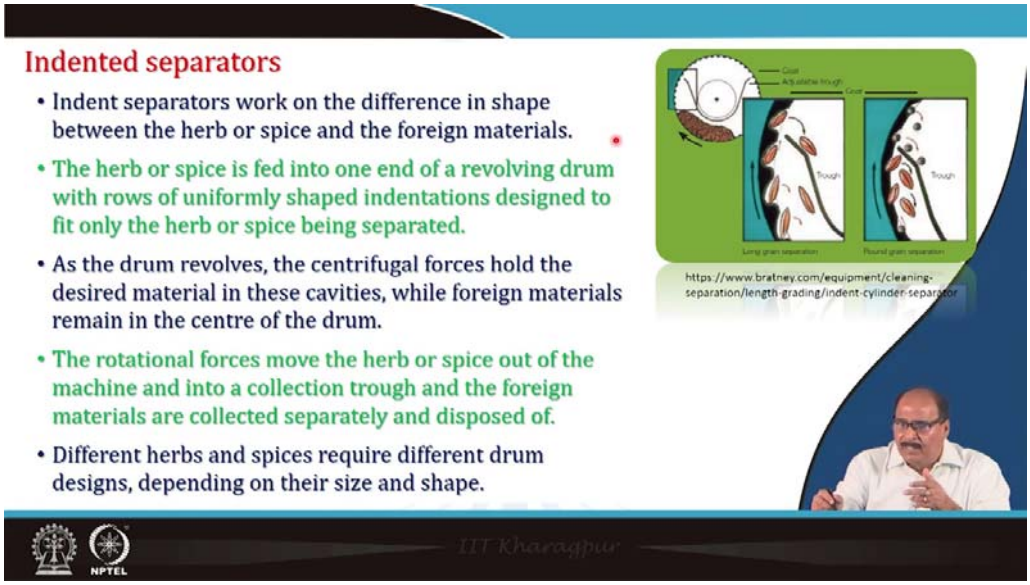
Air tables separate light and heavy materials, and are commonly used for cleaning spices. The spice is put on a wire mesh screen fixed to the table and a stream of air is passed through the screen. Light materials are suspended higher in the air and are thrown out by the force of the air. Rotational vibration is adjusted so that heavy particles are pushed up the screen by repeated tapping. The tilt, rotational vibration of the screen, and the air flow, are adjustable as per specified requirements for the particular spice being cleaned.



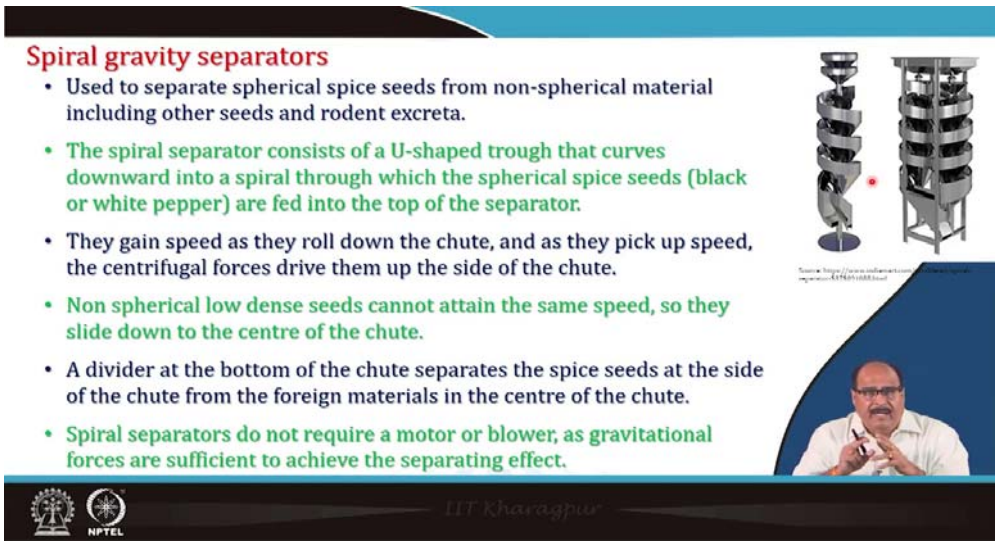
Air separators also work on the same principle as that of air tables. The difference here is that a thin stream of the herb or spice is made to fall through a horizontal air flow. Heavier particles fall straight to the bottom, while lighter particles are blown to the side. Some air separators operate with a vertical flow of air, but the principle of operation is the same.



De-stoners work according to the same principles as air tables and are generally smaller than air tables. They are used to remove heavy stones and pieces of rock, while air tables separate the product into as many groups as necessary. The air flow, inclination and vibration of the screen, and the type of screen used, are adjusted as per the materials being separated.

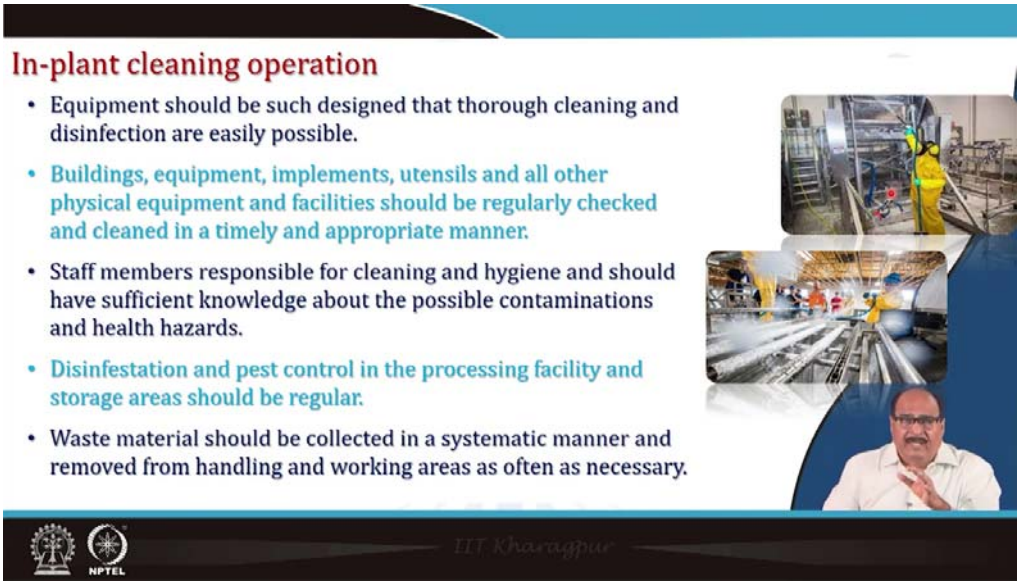


Indent separators work on the difference in shape between the herb or spice and the foreign materials. The herb or spice is fed into one end of a revolving drum with rows of uniformly shaped indentations designed to fit only the herb or spice being separated. As the drum revolves, the centrifugal forces hold the desired material in these cavities, while foreign materials remain in the centre of the drum. The rotational forces move the herb or spice out of the machine and into a collection trough and the foreign materials are collected separately and disposed of. Different herbs and spices require different drum designs, depending on their size and shape.



Spiral gravity separators are used to separate spherical spice seeds from non-spherical material including other seeds and rodent excreta. The spiral separator consists of a U-shaped trough that curves downward into a spiral through which the spherical spice seeds (black or white pepper) are fed into the top of the separator. They gain speed as they roll down the chute, and as they pick up speed, the centrifugal forces drive them up the side of the chute. Non spherical low dense seeds cannot attain the same speed, so they slide down to the centre of the chute. A divider at the bottom of the chute separates the spice seeds at the side of the

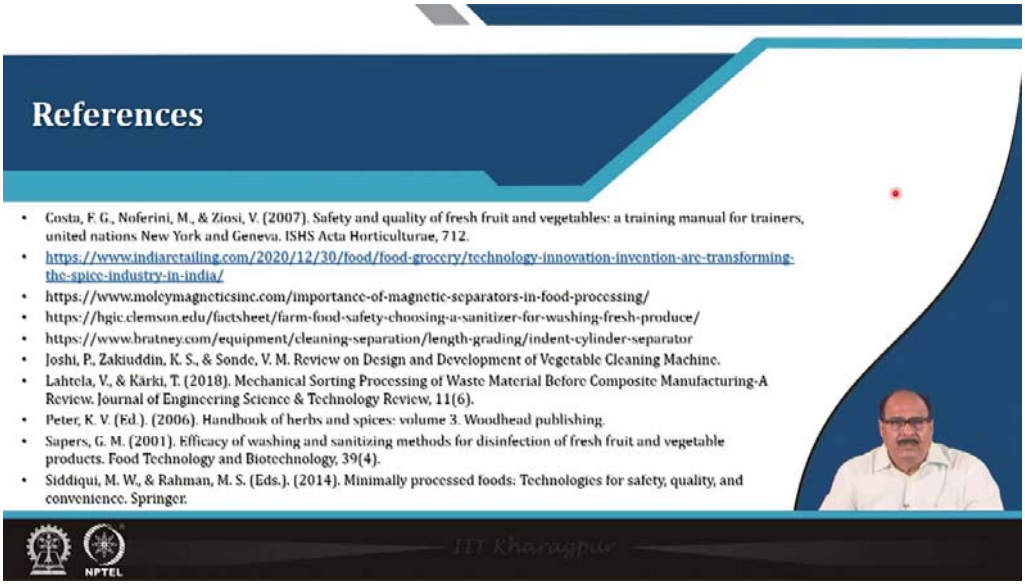
chute from the foreign materials in the centre of the chute. Spiral separators do not require a motor or blower, as gravitational forces are sufficient to achieve the separating effect.



The above equipments are used for the on-farm cleaning operation, but the same system can be used for in-plant cleaning as well. But there are certain points to be noted for the important for the in-plant cleaning like equipment should be such designed that thorough cleaning and disinfection are easily possible. Buildings, equipment, implements, utensils and all other physical equipment and facilities should be regularly checked and cleaned in a timely and appropriate manner. Staff members responsible for cleaning and hygiene and should have sufficient knowledge about the possible contaminations and health hazards. Disinfestation and pest control in the processing facility and storage areas should be regular. Waste material should be collected in a systematic manner and removed from handling and working areas as often as necessary.

In summary, cleaning is very important operation in a food industry as it reduces the likelihood of diseases or their spread, facilitates packaging and handling, and reduces damage

to other produces. Cleaning equipment must take into consideration the size, shape and density of the fruits, vegetables, herbs or spices to be cleaned. Cleaning in a factory fitted with modern equipment is very important to ensure that the end-product is of sufficient quality. The employees and operators in food processing plants must ensure safe cleaning and washing practices.



These are the references for further study. Thank you.