

1. Cleaning:

Cleaning is the unit operation in which contaminating materials are removed from the food and separated to leave the surface of the food in a suitable condition for further processing. A classification of the type of contaminants found on raw foods is shown in Table 1. Peeling fruits and vegetables, skinning meat or descaling fish may also be considered as cleaning operations. In vegetable processing, blanching also helps to clean the product.

Table 1: Contaminants found on raw foods

Type of contaminant	Examples
Metals	Ferrous and non-ferrous metals, bolts, filings
Mineral	Soil, engine oil, grease, stones
Plant	Leaves, twigs, weed seeds, pods and skins
Animal	Hair, bone, excreta, blood, insects, larvae
Chemical	Fertiliser, pesticides, herbicides
Microbial cells	Soft rots, fungal growth, yeasts
Microbial products	Colours, flavours, toxins

In cleaning his raw material, the processor has two main **objectives**: (i) the removal of contaminants which constitute a health hazard or which are aesthetically unacceptable; (ii) the control of microbiological loads and chemical and biochemical reactions which impair subsequent process effectiveness and product quality.

An acceptable cleaning process must satisfy the following requirements:

- i. The separation efficiency of the process must be as high as possible consistent with minimum wastage of good material.
- ii. The contaminant must be removed completely after separation so as to avoid recontamination of the cleaned food.
- iii. The process and equipment should be so designed as to limit recontamination of the cleaned food e.g. by flying dust or by contaminated wash water from previous batches.
- iv. The cleaning process must leave the cleaned surface in an acceptable condition.
- v. Product damage must be avoided.
- vi. Volumes and strengths of liquid effluents must be kept to a minimum and disposed of effectively.

Equipment for cleaning is categorized into wet procedures (for example soaking, spraying, flotation washing and ultrasonic cleaning) and dry procedures (separation by air, magnetism or physical methods). The selection of a cleaning procedure is determined by the nature of the product to be cleaned and by the types of contaminant to be removed. In general, more than one

type of cleaning procedure is required to remove the variety of contaminants found on most foods.

1.1 Wet cleaning

Wet cleaning is more effective than dry methods for removing soil from root crops or dust and pesticide residues from soft fruits or vegetables. It is also dustless and causes less damage to foods than dry methods. Different combinations of detergents and sterilants at different temperatures allow flexibility in operation. However, the use of warm cleaning water may accelerate chemical and microbiological spoilage unless careful control is exercised over washing times and subsequent delays before processing. Examples of wet-cleaning equipment include spray washers, brush washers, drum or rod washers, ultrasonic cleaners and flotation tanks.

1.2 Dry cleaning

Dry cleaning procedures are used for products that are smaller, have greater mechanical strength and possess lower moisture content (for example grains and nuts). After cleaning, the surfaces are dry, to aid preservation or further drying. Dry procedures generally involve smaller cheaper equipment than wet procedures do and produce a concentrated dry effluent which may be disposed of more cheaply. The main groups of equipment used for dry cleaning are:

- ✓ air classifiers
- ✓ magnetic separators
- ✓ separators based on screening of foods

1.3 Removing contaminants and foreign bodies

Physical separation of contaminants from foods is possible when the food has a regular well-defined shape. For example round foods (peas, blackcurrants and rapeseed) are separated from contaminants by exploiting their ability to roll down an inclined, upward moving conveyor belt. Contaminants, such as weed seeds in rape-seed or snails in blackcurrants, are carried up the conveyor and separated. A disc separator, used to separate grain from weed seeds, consists of a series of vertical metal discs with precisely engineered indentations in the sides that match the shape of the grain. As the discs rotate, the grain is lifted out and removed. Screens are also used to remove contaminants from foods.

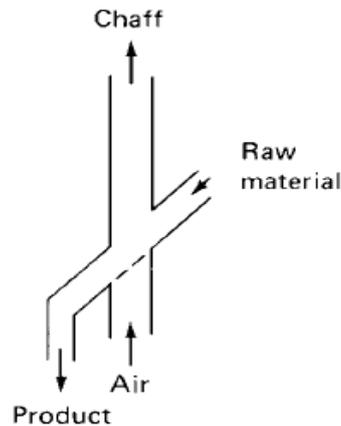


Figure: Separation of chaff from grain by aspiration cleaning.

Contamination by metal fragments or bolts from machinery is a potential hazard in all processing. Raw materials may pass through metal detectors before processing and all packaged foods are checked for contamination. Ferrous metals are removed by either permanent magnets or electromagnets. Electromagnets are easier to clean (by switching off the power supply) but permanent magnets are cheaper. However, unless regularly inspected, permanent magnets may build up a mass of metal which is lost into the food all at once to cause gross recontamination. Small-particulate foods may be automatically checked for contaminants using microprocessor controlled colour sorting equipment. For example, coffee beans are viewed in ultraviolet light to cause bacterial contaminants to fluoresce. More recent developments enable contaminants having the same colour, but a different shape to the product, to be removed (for example green stalks from green beans).

X-rays are used to detect metals and other types of solid contaminant in both raw materials and inside packaged foods. The X-rays pass through the food as it passes on a conveyor and are converted to visible light by a phosphor strip or screen. The light is magnified and transmitted by fibre optic cables to an image intensifier and video camera. The final image is displayed on a television monitor. The system activates a warning and also automatically rejects the contaminated item.

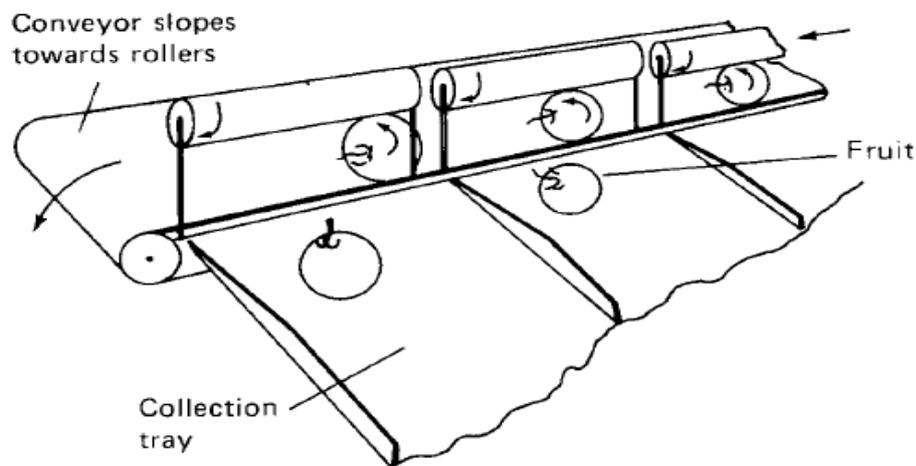
2. Sorting:

Sorting is the separation of foods into categories on the basis of a measurable physical property. Like cleaning, sorting should be employed as early as possible to ensure a uniform product for subsequent processing. The four main physical properties used to sort foods are size, shape, weight and colour.

2.1 Size and Shape Sorting:

The particle size distribution of a material is expressed as either the mass fraction of material that is retained on each sieve or the cumulative percentage of material retained.

The shape of some foods is important in determining their suitability for processing or their retail value. For example, for economical peeling, potatoes should have a uniform oval or round shape without protuberances. Cucumbers and gherkins are more easily packaged if they are straight, and foods with a characteristic shape (for example pears) have a higher retail value if the shape is uniform. Shape sorting is accomplished either manually or mechanically (for example the belt-and-roller sorter in Fig. or the disc sorter) or by image processing.



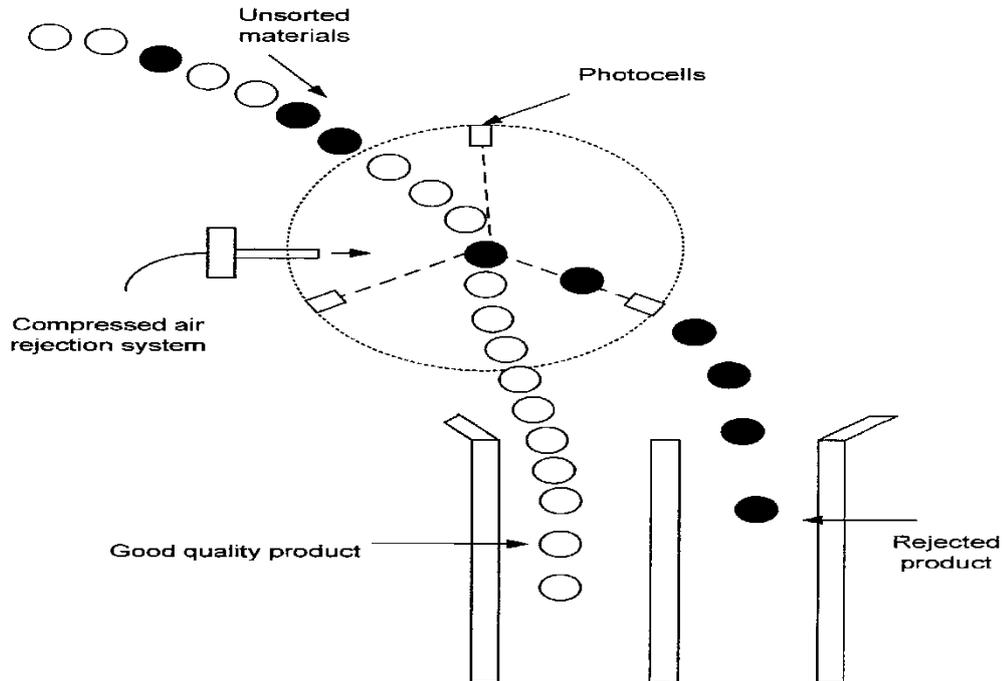
Size sorting (termed sieving or screening) is the separation of solids into two or more fractions on the basis of differences in size. It is particularly important when the food is to be heated or cooled as the rate of heat transfer is in part determined by the size of the individual pieces and variation in size would cause over-processing or under-processing. Additionally, foods which have a uniform size are said to be preferred by consumers. Screens with either fixed or variable apertures are used for size sorting. The screen may be stationary or, more commonly, rotating or vibrating.

2.2 Colour Sorting

Separates the discoloured materials which occur due to insect invasion, disease infection and weathering effect. This type of colour sorter operating on the basis of photometric scanning of the surface of each food unit as it falls or it's rotated before a photocell/ photo detector. Food particles are fed through a chute where the angle, shape and lining material of the chute are controlled, while passing through the photo-detector. Photo-detector measures the colour of each piece food units and compares it with pre-set standard signals. The defective foods are separated by a short blast of compressed air as rejected materials, while good quality products are collected for further processing.

Application of colour sorter:

Widely used to sort & grade foods like nuts, rice, beans, coffee, tea, diced carrot, snack foods and pulses etc.



2.3 Weight Sorting:

Weight sorting is more accurate than other methods and is therefore used for more valuable foods (for example eggs, cut meats and some tropical fruits). Eggs are sorted at up to $12\,000\text{h}^{-1}$ into six to nine categories with a tolerance of 0.5 g. They are first graded by ‘candling’ and then pass to the weight sorter. This consists of a slatted conveyor which transports the eggs above a series of counterbalanced arms. The conveyor operates intermittently and while stationary, the arms raise and weigh the eggs. Heavy eggs are discharged into a padded chute and lighter eggs are replaced on the conveyor to travel to the next weigher.

2.4 Reasons for sorting:

Sorting plays an important part in controlling the effectiveness of many food processes. Sorted foods have the following desirable attributes:

- i. They are better suited to mechanized operations such as peeling, blanching, pitting and coring.
- ii. They are necessary in processes in which uniformity of heat transfer is critical (e.g. sterilization and pasteurization) and they are advantageous in processes in which uniformity of heat transfer is desirable (e.g. dehydration and freezing).
- iii. They give better control over the weights filled into standard sale containers.
- iv. In consumer use, sorted products are more attractive to the eye and allow the serving of uniformly sized portions. This latter point is of particular importance in catering packs.

3. Grading

Grading is also a separation operation where the raw materials are separated into categories on the basis of different quality aspects. Therefore, grading involves overall assessment of all those properties of a material which affect its acceptance as a food.

Grading Factors: The factors which taken into consideration during grading of foods are-

- ✓ Size and shape of food raw materials
- ✓ Maturity index
- ✓ Texture
- ✓ Flavor and aroma
- ✓ Freedom from contaminants
- ✓ Freedom from undesired parts of the raw materials
- ✓ Conformity with the legal standards

Grading Methods: Methods of grading of foods are fall into two groups-

- a. Procedures in which the quality is determined by laboratory tests on samples drawn statistically from a batch of food. For example: the quality of wheat flour is determined by its protein content, colour, moisture content, dough extensibility etc.
- b. Procedures which result in the physical separation of the total quantity of the food into quality categories. for example: maturity index, texture, flavour & aroma, freedom from contamination, conformity with the legal standards

4. Peeling

Peeling is used in the processing of many fruits and vegetables to remove unwanted or inedible material, and to improve the appearance of the final product. The main consideration is to minimize costs by removing as little of the underlying food as possible and reducing energy, labor and material costs to a minimum. The peeled surface should be clean and undamaged.

There are five main methods of peeling:

- ✓ flash steam peeling
- ✓ knife peeling
- ✓ abrasion peeling
- ✓ caustic peeling
- ✓ flame peeling.