Quality parameters and specification in fruits, vegetables and cut flowers

The quality of fresh fruits and vegetables may be explained in terms of the following:

1. Fresh market quality
2. Edible quality
3. Storage quality
4. Transport quality
5. Shipping quality
6. Table quality
7. Internal quality
8. Nutritional quality
9. Appearance quality
10. Processing quality

a. Quality of fresh horticultural commodities is a combination of characteristics, attributes and properties that give the commodity value to humans for food (fruits and vegetables) and enjoyment(ornamentals).
b. The term quality implies the degree of excellence of a produce or its suitability for a particular use.
c. Quality is a human construct comprising many properties or characteristics.
d. Quality of produce encompasses sensory properties (appearance, texture, taste and aroma), nutritive values, chemical constituents, mechanical properties, functional properties and defects. The word "quality" is used in various ways in reference to fresh horticultural produce.

a. For producers of horticultural crops "**good quality**" produce (fruits, vegetables or flowers) should give high yield with **good appearance, disease resistance, insect resistance, good transport quality and bring higher profit.**
b. To receivers and **market distributors, appearance quality is most important and also the firmness and long storage quality.**
c. Consumers consider good quality fruits, vegetables or flowers to be those that have good fresh market quality i.e., **good appearance, good colour, firm or tender (good and optimum texture), good flavour and nutritive value.**
d. Although, consumers buy on the basis of appearance and feel, their satisfaction and repeat purchase are dependent **upon good edible quality in case of fruits and vegetables.**

Quality components: The different components of quality are listed in the following table.

These components are used to evaluate quality of the commodities in **specifications for grade and standard, selection in breeding programme**, and evaluation of responses to various **environmental factors and post harvest treatments.**

S.No	Main factors	Components
1.	Appearance(visual)	Size, dimension, weight, volume, shape and form, smoothness, compactness, uniformity colour, uniformity and intensity Gloss, nature of surface wax Defects: external, internal (morphological, physical and mechanical, physiological, pathological and entomological)
2.	Texture	Firmness, hardness or softness, Crispness, succulence, juiciness, Mealiness, grittiness, fibrousness, Toughness
3.	Flavour (Taste and smell)	Sweetness, sourness(acidity), astringency, bitterness, aroma, off odour, off flavour
4.	Nutritive value	Contents of carbohydrates, proteins, Lipids, vitamins, minerals, fiber, water Antioxidants *etc.*
5.	Safety Naturally	occurring toxicants, Contaminants(chemical residues, heavy metals) Mycotoxins Microbial contamination

Quality systems

a. Management of quality in horticulture industries in whole distribution chain from farm gate to final point of sale requires holistic approach.
b. To achieve this, it is necessary to monitor and prevent quality problems as early as possible in the production or initial post production process rather then relaying on end point.
c. Among quality assurance systems

1. **ISO 9000 series was used initially but it is a slow process.**
2. **HACCP (Hazard Analysis Critical Control Point) risk management approach systems – It** enable to assess the risk and thus identify what go wrong, establish control to minimizes the likelihood of such an occurrence and take corrective action to manages those wrongs.

The 7 steps in HACCP are

- Identify and assess all hazards
- Identify the critical control points
- Identify the critical limits
- Establish the monitoring procedures
- Establish the corrective actions
- Establish a record-keeping systems
- Establish verification procedures

Based on HACCP, many systems has been established such as

- EurepGAP – European Good Agriculture Practices
- SQF 2000 ™ - Safe Quality Foods

Fruits and vegetables are graded into different categories based on sensory quality as well as **physical attributes like weight and size**. While formal grades and standards are specified codex almintorious for certain fruits and vegetables, many commodities are not covered under this.

Informal grading based on **physical appearance and sizes** are practiced in trade. Some of the standard used in export trade of important fruits and vegetable are listed below.

Weight grading standards of fruits for export purpose

Crop	A grade	B grade	C grade
Mango	200-350 g	351-550 g	551-800 g
Grape (Bunch)	300 (Extra class)	250 (Class I	150 (Class II)
Pomegranate	350 g & above	250-350 g	<200 g
Figs	50 g above	40-50 g	30-40 g
Papaya	200-700 g	700-1300 g	1300-1700 g
Guava	>450 g	351-450 g	251-350 g
Pineapple (with crown)	2750 g	2300 g	1900 g
Litchi (diameter)	33 mm	20 mm	-
Lime Minimum wt:	75 g and minimum diameter: 4 cm		

Quality or grading standards for vegetables

Crop	Specific requirement
Okra	Green, tender, 6-9 cm long
Chilies	Green, 6-7 cm long
Cluster bean	Green, tender, 7-10 cm long
Bitter gourd	Green, 20-25 cm long having short neck
Bottle gourd	Light green, straight, cylindrical, 25-30cm long
Tomato	Round, medium size in middle east, cherry tomatoes in European countries
French bean	10-12 cm long, straight, round green pods in bush beans Flat beans with 12-13 cm & straight are also demand in European markets
Big onion	4-6 cm, light to dark red, round , strong pungency for gulf & SEA markets Yellow/brown colour, 7-10 cm, round or spindle shape for European & Japan markets
Small onions	2-3 cm dark red and round
Garlic	White, round, 5 cm & above, bigger cloves of 10-12 cm & above with 10-15 in number. For Bangladesh and Sri Lanka 4-5 cm size bulbs also acceptable
Potato	White, oval, 4.5 to 6 cm. Bangladesh demands red type and Iran & Iraq demands potatoes with yellow flesh

PACKAGING

a. **PACKAGING is defined as "Techno-economic" function arrived at minimizing cost of delivery while maximizing sales.**
b. The main function of **packaging fruits, vegetables and flowers is to assemble the produce into convenient units for better handling and to protect them.**
c. A good package should **aim at protection of produce from physical, physiological and pathological deterioration throughout storage, transport and marketing.**
d. In recent times, packaging is becoming an essential part of supply chain of horticultural crops because of the consumer's choice for **convenience, appeal, information and branding**

Selection of packaging material:

a. **Selection of suitable containers for commercial-scale marketing requires careful consideration. Besides providing a uniform-size package to protect the produce, there are other requirements for a container;**
b. It should be easily transported when empty and occupy less space when full, e.g. plastic boxes which nest in each other when empty, collapsible cardboard boxes, fibre or paper or plastic sacks.
c. It must be easy to assemble, fill and close either by hand or by use of a simple machine.
d. It must provide adequate ventilation for contents during transport and storage.
e. Its capacity should be suited to market demands
f. Its dimensions and design must be suited to the available transport in order to load neatly and firmly.
g. It must be cost-effective in relation to the market value of the commodity for which used
h. It must be readily available, preferable from more than one supplier.

Packaging for fresh produce is of several types as follows:

1. Natural materials: Baskets and other traditional containers made from **bamboo, rattan, straw, palm leaves** etc. are used as packaging material throughout the developing world. Both the raw materials and labour costs are normally low and if the containers are well made, they can be reused.

Disadvantages:

a. They are difficult to clean when contaminated with decay organisms.
b. They lack rigidity and bend out of shape when stacked for long-distance transport.
c. They load badly because of their shape.
d. They cause pressure damage when tightly filled.
e. They often have sharp edges or splinters causing cut and puncture damage.

2. Wood: Sawn wood is often used to make reusable boxes or crates. In recent times their use has become limited because of their prohibitive costs. Veneers of various thicknesses are used to make lighter boxes and trays. Wooden boxes are rigid and reusable and if made to a standard size, stack well on trucks.

Disadvantages:

a. They are difficult to clean adequately for multiple uses.
b. They are heavy and costly to transport.
c. They often have sharp edges, splinters and protruding nails, requiring some form of liner to protect the contents.

3. Wire-Bound Crates:

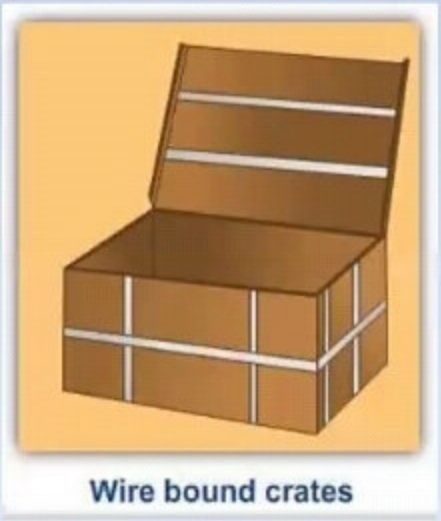
a. Wooden wire-bound crates are used extensively for **snap beans, peas, sweet corn** and several other commodities that require **hydro cooling**.

b. Wire-bound crates are **sturdy, rigid and have very high stacking strength** that is essentially unaffected by water.

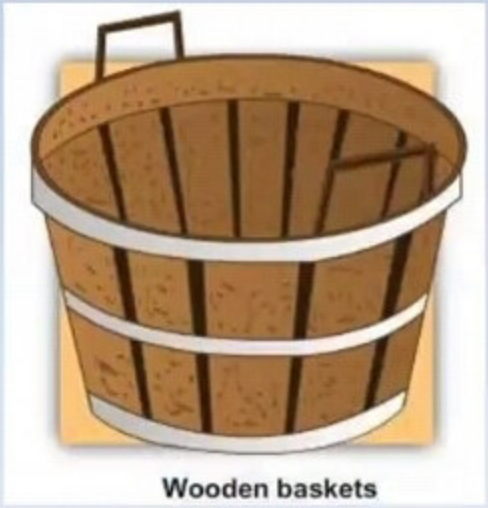
c. Wire-bound crates have a great deal of open space to facilitate cooling and ventilation. Although few are re-used, wire-bound crates may be dissembled after use and shipped back to the packer.

d. In some areas, used containers may pose a significant disposal problem.

e. They are not generally acceptable for consumer packaging because of the difficulty in affixing suitable labels.



Wire bound crates



Wooden baskets

Advantages of CFB cartons over the conventional wooden boxes

a. Minimal bruising damage
b. Easy handling and stacking
c. More economical transport
d. Can be turned quickly into highly precise and accurate size
e. Can be appropriately punched, ventilated, printed low cost
f. Made pilfer-proof and reveal tampering at a glance
g. Offer the most acceptable packaging in the international markets
h. Collapsible and occupy less volume for storage of empty cartons
i. Cartons can be used for cold storage conditions giving water proof treatment
j. Can be made stronger by reinforcing with Hessian or nylon fibre

Disadvantages:

a. They may, if used only once, prove an expensive recurring cost (if multiple use is intended, the boxes may be easily collapsed when empty).
b. They are easily damaged by careless handling and stacking
c. They are seriously weakened if exposed to moisture
d. They can be ordered economically only in large quantities.
e. Small quantities can be prohibitively expensive.

5. Molded plastics:

a. Reusable boxes molded from high-density polythene are widely used for transporting produce in many countries.
b. They can be made to almost any specifications.
c. They are strong, rigid, and smooth, easily cleaned and can be made to stack when fully of produce and nest when empty in order to conserve space.

6. Natural and synthetic fibres:

a. Sacks or bags for fresh produce can be made from natural fibres like jute or sisal or from synthetic polypropylene or polyethylene fibres or taps.
b. "Bags" usually refers to small containers of upto about 5 kg capacities.
c. They may be woven to a close texture or made in net form. Nets usually have a capacity of about 15 kg.
d. Bags or sacks are mostly used for less easily damaged produce such as potatoes and onions, but even these crops should be handled carefully to prevent injury.

a. **Disadvantages:**
b. They lack rigidity and handling can damage contents.
c. They are often too large for careful handling. Sacks dropped or thrown will result in severe damage to the contents.
d. They impair ventilation when stacked if they are finely woven.
e. They may be so smooth in texture that stacks are unstable and collapse.
f. They are difficult to stack on pallets.

7. Paper:

a. Paper or plastic film is often used to line packing boxes in order to reduce water loss of the contents or to prevent friction damage. Paper sacks can have walls of up to six layers of Kraft (heavy wrapping) paper.
b. They can have a capacity of about 25 kg and are mostly used for produce of relatively low value.
c. They can be closed by machine stitching across the top (recommended only for large-scale crop production) or in the field by twisting wire ties around the top by means of simple tools.

Disadvantages:

a. Walls of paper are permeable to water or vapour and gases.
b. Heat can be slow to disperse from stacks of sacked produce, thus damaging fruit or leafy vegetables.
c. Limited protection to contents if sacks are mishandled.

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8. Plastic/Paper pulp trays Containers made from recycled paper pulp and a starch binder is mainly used for small consumer packages of fresh produce. Pulp containers are available in a large variety of shapes and sizes and are relatively inexpensive in standard sizes. Pulp containers can absorb surface moisture from the product, which is a benefit for small fruit and berries that are easily harmed by water. Pulp containers are also biodegradable, made from recycled materials, and recyclable.

Packing individual fruit in moulded plastic

9. Paper and Mesh Bags

Consumer packs of potatoes and onions are about the only produce items now packed in paper bags. The more sturdy mesh bag has much wider use. In addition to potatoes and onions, cabbage, turnips and some specialty items are packed in mesh bags. In addition to its low cost, mesh has the advantage of uninhibited air flow. Good ventilation is particularly beneficial to onions.

However, bags of any type have several serious disadvantages. Large bags do not palletize well and small bags do not efficiently fill the space inside corrugated fiberboard containers. Bags do not offer protection from rough handling. Mesh bags provide little protection from light or contaminants. In addition, produce packed in bags is correctly perceived by the consumer to be less than the best grade.

a. Stretch/cling wrap

I. This is actually a polyethylene or polypropylene film which has the property that under tension it stretches and when the tension is released it comes back to its original form.

II. This property helps in packaging the product tightly.

III. The whole operation can be carried out without application of the heat.

IV. Eg. Cabbage, fresh cut vegetables *etc.*

b. Rigid Plastic

Packages with a top and bottom that are heat formed from one or two pieces of plastic are known as clamshells.

Clamshells are gaining in popularity because they are inexpensive, versatile, provide excellent protection to the produce and present a very pleasing consumer package. Clamshells are used extensively with pre-cut produce and prepared salads.

Consumer packs wrapped in plastic are not recommended under tropical Importance of ventilation – (conditions except in stores with refrigerated display cabinets. Importance of ventilation – (FB bores with ventilation best for transportation as it reduced the physiological loss in weight.

Modified atmosphere package - MAP

a. MAP does control of gas concentration (O_2 and CO_2) in atmosphere surrounding the commodity.
b. Oxygen and CO_2 can be controlled by the chemical (eg. polymers type) or physical (thickness) characteristics of the film and holes in the film.
c. Oxygen and CO_2 flux through the hole is propositionally greater in magnitude than water vapour and C_2H_4 flux because of their flux is driven by comparatively large concentration gradients.
d. Oxygen diffuses faster than CO_2 through hole on account of its grater diffusion coefficient.
e. In contrast, all plastic films are relatively more permeable to CO_2 than O_2.
f. Both CO_2 than O_2 (reactive gas) can be chemically scrubbed from packages and filled with inert gas like N_2.

Films available for MA Packaging

1. LD Polyethylene,
2. HD Polyethylene
3. Polyethylene - Cast and Oriented
4. Rigid PVC
5. Ethylene Vinyl Acetate

Fig. Wrapping individual fruits in old news paper

Fig. Individual protection for fruits using foam net

1. Vacuum packaging

a. Vacuum packaging offers an extensive barrier against **corrosion, oxidation, moisture, drying out, dirt, attraction of dust by electric charge, ultra violet rays** and **mechanical damages, fungus growth or perishability** etc.

b. This technology has commendable relevance for **tropical countries** with **high atmosphere humidity**.

c. In vacuum packaging the product to be packed is put in a **vacuum bag** (made of special, hermetic fills) that is then evacuated in a vacuum chamber and then sealed hermetically in order to provide a **total barrier against air and moisture.**

d. If some of the product cannot bear the atmosphere pressure due to vacuum inside the package then the packages are flushed with inert gases like **Nitrogen and CO_2** after evacuation.

2. Individual seal /shrink packaging technique

a. Individual seal packaging, which may be considered as the MAP for an individual fruit, involves sealing of a fruit in a plastic film with or without heat shrinking to conform the shape of a fruit.
b. Individual seal packaging would help to **reduce the fruit decay by prevention of secondary infection during long term storage or shipment.**
c. Seal packaging has been found to extend the shelf life of several fruits like **apple, pear, kiwifruit, citrus and pomegranate.**

3. GRAPE GUARD

a. Grape guards are chemically treated paper-sheets using active ingredient – Anhydrous Sodium Bisulfite ($Na_2S_2O_5$).
b. Grape guard paper is a special chemically treated **cellulosic antifungal paper** that regulates the **release of SO_2 concentration at around 80 ppm for over 12 weeks at a time in each individual carton of grapes.**
c. Their function is to preserve the quality of grapes in store and transit by control of decay.
d. Grape guards **improve quality** by obtaining **sturdy, bright un-shrivelled appearance** of fruit.

They are available in two types.

a. Quick release grape guard

b. Dual release grape guard

a. Quick release grape guard retards **decay development** up to **three weeks at 0°C**.

b. It can help for a few days to **control decay without refrigeration.**

c. Dual release grape guards can be used for **decay retardation up to 12 weeks** in storage or transit with refrigeration facilities. It is effective **only at 0°C**.

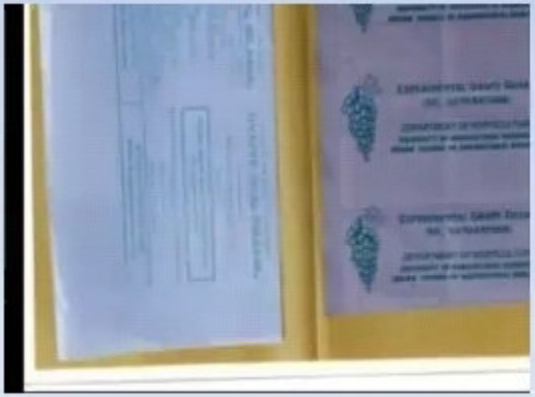

Fig. Grape guard in craft paper

Packing grapes in carton

a. Corrugated fiber board boxes three ply with a capacity of 2 kg and 5 kg having a dimension of 25x20x12 cm is being used for packing.
b. Use of fresh paper shavings as cushioning material to minimize transportation damages to the grape bunches is advocated.
c. Different packaging materials like kraft paper, butter paper and soft tissue paper for preparation of grape guard is used.
d. Grape guard containing 6 and 9 gram of sodium bisulphite is good.
e. Berry decay and berry drop was controlled by the use of grape guards with containing 9 g sodium bisulphite.
f. Grape guards containing sodium bisulphite extended the shelf life of Thompson Seedless, Anab-e-Shashi, Dilkush and Sharad Seedless grapes upto 14, 8, 8 and 16 days respectively at ambient temperature and upto 75, 60, 75 and 85 days respectively under cold storage conditions.

Types of Containers

1. Field containers
2. Shipping containers
3. Consumer packages
4. Shrink-film wraps

1. **Field containers**: Picking containers are of many types, depending upon the **crop, region and availability of materials. Picking bags of canvas, mesh hampers and baskets of woven veneer or bamboo are widely used.**

2. **Shipping containers**: The ideal pack consist of tight fill without a bulge in a lidded container having sufficient stacking strength to protect the contents from all the hazards. In India, baskets and boxes are often used as containers. **Fireboards cartons are becoming popular for shipping both tropical and sub tropical fruits**. Their lightweight and low cost are advantages.

3. **Consumer packages**: use of small sized packages for produce has grown with the increase in large self – service markets for retailing. **Bags, plastic films and mesh bags are used as consumer packages.**

4. **Shrink-film wraps**: Films such as **polypropylene, polystyrene, Polyethylene and rubber hydrochloride** can be converted into shrink films by molecular orientation methods. After the shrink film is applied to the filled trays in tabular or heat-sealed wrap form, the packages are through a heat tunnel to shrink the film cover. This immobilizes the commodity to reduce the possibility of physical damage during hadling.

Quality of an ideal Package:

1. It should contain the content within it.
2. It should not affect the flavour of the product packed inside of it.
3. Stable performance over large range of temperature.
4. Adequate compulsive strength and sufficient impact and puncture strength.
5. Sufficient space for rapid cooling of contents.
6. Protect the content from oxygen, moisture and light.
7. Compatible to the food product.
8. Protection of the content from adulteration.
9. Closure characteristics such as opening, sealing, resealing and pouring.
10. Proper labelling, strong marketing appeal to promote the sale of food product.
11. Low cost and availability.
12. Bio degradability and recyclability.

Cushioning Materials:

a. The function of cushioning materials is to fix the commodities inside the packages and prevent them from mixing about in relation to each other and the package itself, when there is a vibration or impact.
b. Some cushioning materials can also provide packages with additional stacking strength.
c. The cushioning materials used vary with the commodity and may be made of wrapping papers, Fibreboard (single or double wall), Moulded paper pulp trays, Moulded foam polystyrene trays, Moulded plastic trays, Foam plastic sheet, Plastic bubble pads, Fine shredded wood, Plastic film liners or bags.

Controlled and Modified Atmospheric Packaging (CAP and MAP)

a. The normal composition of air is 78% Nitrogen, 21% Oxygen, 0.03% Carbon dioxide and trees of the noble gases.
b. Modified atmosphere packaging is the method for extending the shelf life of perishable and semi-perishable food products by altering the relative proportions of atmospheric gases that surround the produce.
c. Although the terms controlled atmosphere (CA) and modified atmosphere (MA) are often used interchangeably a precise difference exists between these two terms.

Controlled atmosphere (CA)

a. **This refers to a storage atmosphere that is different from the normal atmosphere in its composition, wherein the component gases are precisely adjusted to specific concentrations and maintained throughout the storage and distribution of the perishable foods.**
b. Controlled atmosphere relies on the continuous measurement of the composition of the storage atmosphere and injection of the appropriate gases or gas mixtures into it, if and when needed.
c. Hence, the system requires sophisticated instruments to monitor the gas levels and is therefore practical only for refrigerated bulk storage or shipment of commodities in large containers.
d. If the composition of atmosphere in CA system is not closely controlled or if the storage atmosphere is accidentally modified, potential benefit can turn into actual disaster.
e. The degree of susceptibility to injury and the specific symptoms vary, not only between cultivars, but even between growing areas for the same cultivars and between years for a given location.
f. With tomatoes, excessively low O_2 or high CO_2 prevents proper ripening even after removal of the fruit to air, and CA enhances the danger of chilling injury.

Modified atmospheric packaging (MAP)

a. Unlike CAPs, there is no means to control precisely the atmospheric components at a specific concentration in MAP once a package has been hermetically sealed.
b. Modified atmosphere conditions are created inside the packages by the commodity itself and / or by active modification.
c. Commodity – generated or passive MA is evolved as a consequence of the commodity's respiration.
d. Active modification involves creating a slight vacuum inside the package and replacing it with a desired mixture of gases, so as to establish desired EMA quickly composed to a passively generated EMA. Another active modification technique is the use of carbon dioxide or ethyl absorbers (scavengers) within the package to prevent the build-up of the particular gas within the package.
e. This method is called active packaging. Compounds like hydrated lime, activated charcoal, magnesium oxide are known to absorb carbon dioxide while iron powder is known to absorb carbon dioxide. Potassium permanganate, squakna and phenyl methyl silicone can be used to absorb ethylene within the packages.

a. These scavengers can be held in small sachets within the packages or impregnated in the wrappers or into porous materials like vermiculite.
b. With activity respiring commodities like fruits and vegetables, the package atmosphere should contain oxygen and carbon dioxide at levels optimum to the particular commodity.
c. In general, MA containing between 2-5% Oxygen and 3.8% carbon dioxide have been shown to extend the shelf life of a wide variety of fruits and vegetables.
d. If the shelf life of a commodity at 20-25°C is 1, by employing MAP, it will be doubled, whereas refrigeration can extend the shelf life to 3, and refrigeration combined with MAP can increase it to 4.
e. Few types of films are routinely used for MAP, the important ones are polyvinyl chloride, (PVC), polystyrene, (PS), polyethylene (PE) and polypropylene (PP).
f. The recent developments in co-extrusion technology have made it possible to manufacture films with designed transmission rates of oxygen.