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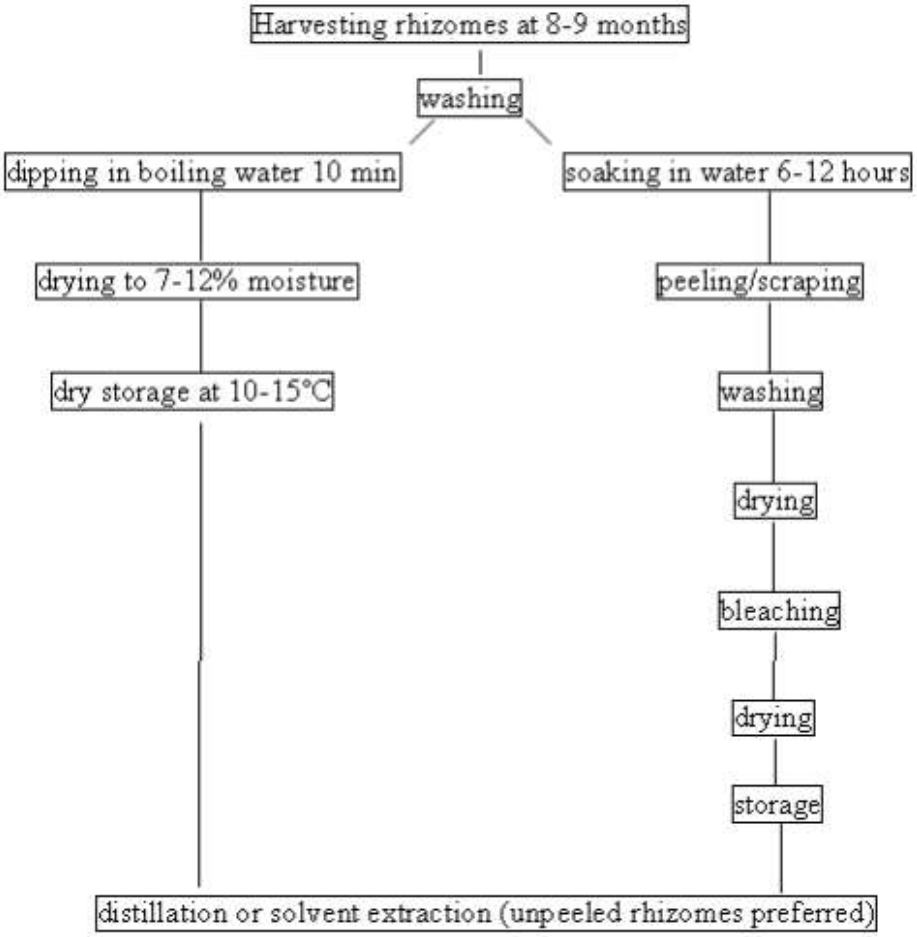
Unit 1 Topic 4

Ginger, Garlic and Onion. Unit operations involved equipment – principle and construction

GINGER

Introduction

- **One of the most important spices cum medicinal plants.**
- **Traced back through Greek *zingiber* to Sanskrit *srngavera*, the name of ginger (*Zingiber officinale* Rosc.) is really of Dravidian origin.**
- **Belongs to the family Zingiberaceae.**
- **It is a herbaceous crop, perennial in nature but cultivated as an annual.**
- **Most promising varieties of ginger are Nadia, Maran, Rio-de-Janeiro, China, Wynad, Ernad, Kuruppampadi, Suprabha, Suruchi, Surabi, Varad and Himgiri.**
- **The aerial stem is the pseudo stem and rhizome, ginger of commerce, is the modified stem for storage of food materials.**
- **Rhizome is the material used for vegetative propagation.**
- **It has nodes covered with scale leaves.**
- **Each node has an axillary bud. The pseudo stem consists of narrow leaves borne on short petioles arranged in distichous manner.**



Harvesting

Ginger attains full maturity in 210-240 days after planting. Harvesting of ginger for vegetable purpose starts after 180 days based on the demand. However, for making dry ginger, the matured rhizomes are harvested at full maturity i.e. when the leaves turn yellow and start drying. Irrigation is stopped one month before harvest and the rhizome clumps are lifted carefully with a spade or digging fork. In large scale cultivations, tractor or power tiller drawn harvesters are also used. The dry leaves, roots and soil adhering on the rhizomes are

manually separated. Late harvest is also practiced, as the crop does not deteriorate by leaving it for some months underground. In India, domestic market prefers fresh green ginger for culinary use while two types of dried ginger i.e. bleached and unbleached are produced for export purpose. The most important criteria in assessing the suitability of ginger rhizomes for particular processing purposes is the fibre content, volatile-oil content and the pungency level. The relative abundance of these three components in the fresh rhizome is governed by its state of maturity at harvest.

Stage of harvest of ginger for various end uses

End use	**Stage of harvest (months after planting)**
Vegetable purpose and preparation of ginger preserve, candy, soft drinks, pickles and alcoholic beverages	5-6
Dried ginger and preparation of ginger oil, oleoresin, dehydrated and bleached ginger	7-8

Processing of ginger

Processing of ginger to produce dry ginger basically involves two stages- peeling of the ginger rhizomes to remove the outer skin and sun drying to a safe moisture level.

Peeling

Peeling serves to remove the scaly epidermis and facilitate drying. Peeling of fully matured rhizomes is done by scrapping the outer skin with bamboo splits having pointed ends and this accelerates the drying process. Deep scraping with knifes should be avoided to prevent the damage of oil bearing cells which are present just below the outer skin. Excessive peeling will result in the reduction of essential oil content of the dried produce. The peeled rhizomes are washed before drying. The dry ginger so obtained is valued for its aroma, flavour and pungency. Indian dried gingers are usually rough peeled when compared to Jamaican gingers, which are clean peeled. The rhizomes are peeled only on the flat sides and much of the skin in between the

fingers remains intact. The dry ginger so produced is known as the rough peeled or unbleached ginger and bulk of the ginger produced in Kerala are of this quality.

Drying

The moisture content of fresh ginger at harvest is about 80-82 per cent which is brought down up to 10 per cent for its safe storage. Generally ginger is sun dried in a single layer in open yard which takes about 8 to 10 days for complete drying. The sun dried ginger is brown in colour with irregular wrinkled surface. The yield of dry ginger is about 19-25 per cent of fresh ginger depending on the variety and climatic zone.

Polishing, cleaning and grading

Polishing of dried ginger is done to remove the dry skin and the wrinkles developed on the surface during drying process. It is generally done by rubbing against hard surface. Cleaning of dry ginger is done manually to remove the extraneous matter and the light pieces. Once the ginger is cleaned and it is graded manually based on size of the rhizome, its colour, shape and the extent of residual lime (in the case of bleached ginger).

Storage

Dry ginger, packaged in gunny bags are highly susceptible to infestation by insects like Lasioderma serricone (cigarette beetle) during storage. Fully dried rhizomes can be stored in airtight containers such as high density polyethylene or similar packaging materials. Long term storage for more than two years would result in deterioration of its aroma, flavour and pungency.

Bleached ginger

Bleached ginger is produced by dipping scrapped fresh ginger in a slurry of slaked lime, Ca(OH)2, (1 kg of slaked lime/120 kg of water) followed by sun drying. As the water adhering to the rhizomes dry, the ginger is again dipped in the slurry. This process is repeated until the rhizomes become uniformly white in colour. Dry ginger can also be bleached by the similar process. Liming gives ginger a better appearance and less susceptibility to the attack of insect pests during storage and shipping.

GARLIC

Garlic (Allium sativum) is one of the important bulb crops grown and used as a spice or condiment throughout India. It is also important foreign exchange earner for India. It is consumed by almost all people who take onion. Garlic has higher nutritive value than other bulb crops. It is rich in proteins, phosphorous, potassium, calcium, magnesium and carbohydrates. Ascorbic acid content is very high in green garlic.

Area, Production and Productivity

The production and productivity of garlic in India are very low compared to many other countries. Unawareness of farmers about improved varieties, climate, soil and agro-techniques, diseases and pest damaging the crops and their control measures as well as post-harvest management are though main reasons, inadequate market support is also responsible for limiting the production and productivity indirectly.

VARIETIES

Garlic varieties, Agrifound White, Yamuna Safed, Yamuna Safed 2 and Yamuna Safed 3 have been notified by the Government of India.

HARVESTING AND CURING

Garlic becomes ready for harvesting when its tops turn yellowish or brownish and show signs of drying up and bend over. G 282 is early-maturing cultivar. Harvesting at the stage when tops have fallen over gives good quality bulbs. Bulbs are taken out along with tops and windrowed gathering several rows in each row for curing.

YIELD

The yields of bulbs vary from 100 to 200q/ha depending upon variety and regions.

SEED PRODUCTION

Garlic is propagated by cloves. Well-grown compact bulbs of uniform shape and size are selected. The cloves having 8-10 cm size are used for planting. The planting method and other operations followed for production of seed are the same as for bulbs production.

POST- HARVEST MANAGEMENT

Many operations are performed for getting mature and quality bulbs from the field to the consumer. About 15-50% losses occur if proper post-harvest management practices are not followed. These practices differ from place-to-place. Proper curing, sorting and grading, transportation and storage are essential to minimize these looses.

DRYING AND CURING

Drying and curing are very essential. Drying is done to remove excess moisture from outer skin and neck to reduce storage rot, while curing is an additional process of drying to remove the excess moisture and to allow the colour development and help the bulbs to become compact and go into dormant stage. It is done for about a week in the field for drying. The method and period of curing vary depending on weather at the time of harvesting. Bulbs are covered along with their tops to avoid damage to bulbs from sun. These are also cured for 7-10 days in shade either with tops or after curing the tops by leaving 2.5 cm above the bulbs and removing the roots. Harvesting at 100% neck fall and curing by windrow method have been recommended. The curing in field till foliage turns yellow should be done. Artificial curing can be done by passing hot air at 27.35ºC through the curing room. It takes about 48 hours for complete curing process if humidity is between 60 - 75%.

SORTING AND GRADING

Garlic bulbs after curing are run over a grader or graded manually before their storage or marketing. The thick- necked, splitted, injured, and diseased or bulbs with hollow cloves are sorted out. Size grading is done after sorting. It is very much necessary for getting better price and to minimize losses on account of drying and decay. Government of India has prescribed certain grade designations for different qualities of garlic for export. The grade designations and definition of different qualities of garlic have been prescribed.

PACKAGING

In India, garlic bulbs are packed in open mesh jute bags for domestic use. It is packed in bags of 90 and 40 kg capacity each in Andhra Pradesh, Karnataka and other garlic, growing states respectively. As per the garlic grading and packing rules, 18 and 25 kg packing are done in perforated 10 ply corrugated cardboard boxes for export. Nylon-netted bags used for packing and further storage cause minimum losses in storage. In foreign countries, plastic-wooven bags are very commonly used. These have good strength and are also attractive. Since garlic needs less ventilation compared to onion, there is a need to develop suitable packaging to reduce drying loss.

STORAGE

Thoroughly cured garlic bulbs are stored well in ordinary well-ventilated rooms. Garlic with dried leaves can be stored by hanging in well-ventilated rooms. This is, however, not possible on commercial scale because space requirement is more. Storage without tops in nylon-netted bags give better performance at Nasik and Karnal as such the same has been recommended for storage to minimize loss. In Jamangar area (Gujarat), some pockets of Indore and Mandsaur, Madhya Pradesh and Manipuri and Etah district of Uttar Pradesh, bulbs are stored for 6-8 months. Since garlic stores well for market under a wide range of temperature, controlled conditioned (low temperature) storage are not necessary. Cloves sprout quickly at

4.4ºC and prolonged storage in this temperature range should be avoided. Storage at 0.5ºC is satisfactory, but high humidities often accompany low temperature storage. Garlic stored at humidity higher than 70% at any temperature develop mould and start rotting. Cold storage of garlic is possible at 32-36ºF and 60-70% relative humidity. The storage loss of 12.5% is recorded in garlic stored at 1-5ºC and 75% relative humidity compared to 42.4% losses in ambient temperature. UV light treatment for 30 minutes further reduces loss to 8% in cold stores for 150 days storage.

ONION

Harvesting

- Onion crop is readily for harvesting in 5 months for dry onion. However, for marketing green onion, the crop becomes ready in three months after transplanting. The crop which is raised from drysets is not fit for production of dry bulbs as it starts bolting and then is fit for marketing as given onion two and half months.

Stage of harvesting

- Onion could safely be harvested after one week of 50 % neckfall. It is the ideal stage for storage of rabi onion.

Method of harvesting

- Onion should be pulled out by hand or with the help of Khurapas and immediately shifted to shade for curing. Harvested bulbs should never be left in main field as scortching may affect the crop. which inturns increases rotting in storage.
- There is steady increase in volatile sulphur until the plants reach the maturity stage. The peak is reached just before the tops begin to fall. In Kharif, after harvesting crop should be left in the field for few days for drying of leaves.

Curing

- If the season is mild, the bulbs after harvesting is left in the field of curing which makes it firm and dry. Where is hot wheather bulbs are removed to the shade for curing. Generally, it takes 6-8 days for curing.
- Bulbs should be save from rains and direct sunlight. Injured, rotten diseased and thick necked bulbs should be sorted out at the time of curing before storage.

Curing

- Onions are thoroughly cured before being stored in crates. Crates filled with topped bulbs are usually stacked in the field and covered with boards, roofing paper, or some other type of covering to protect the onions from injury by sun and rain.
- The crates may be stacked in open curing sheds. The time required to cure onions may be 3-4 weeks or longer depending upon the weather conditions. For mechanically harvested onions, bulk storage instead of crate storage is adopted.
- The onions are harvested and topped in the field with a machine and hauled by wagon or truck to the storage facility and stored in bulk piles 8-10 feet deep. With good aeration, shrinkage of bulk-stored onions due to curing is no greater than that occurring in crates in the field. Field curing (windows) and artificial curing (16 hr at 46^{o}C) reduced losses of onion in storage compared with that non-cured bulbs.
- Artificial curing immediately after harvest greatly reduces losses of onions from neck rot. The cured onions are further cleaned, graded, and packed. The USDA has specified grades for northern grown domestic onions and for Bermuda onions.

Dehydration of onion

- Dehydration process is often defined as controlled drying of a commodity by artificial thermal means. Stability is conferred by the abstraction of water, so that the product is unable to support the microbial growth, its chemical terms of deterioration is inhibition and the drastic reduction in weight and volume facilitates easier handling and marketing.
- Dehydrated onions are becoming a product of considerable importance in international agricultural trade. Onion´s contribution to the total dehydrated product export is 45 %.
- It has been estimated that about 40-60 % annual onion production in India is wasted due to post harvest losses.

Objectives of Onion dehydration

- To find wider market to horticultural produce such as onion
- To preserve onion from microbial attack or from physico-chemical degradation
- To increase export earning
- To provide consumer with onion during the season of shortage
- To facilitate comparatively cheaper and easier handling, packaging and shipment that the bulk of fresh onion

Qualities for dehydrated onion

Product quality

a. Minimum chemical and biochemical degradation reactions
b. Selective removal of water
c. Rapid and simple rehydration
d. Storage stability

Process of economics

a. Minimum product loss
b. In expensive energy sources such as solar
c. Dehydration

Requirement for onion varieties for dehydration

- High pungency (i.e., pyruvic acid content)
- While flesh which do not discolours or develop bitterness (flavour) on dehydration
- High total soluble solids (SS) : 15-20 % or more
- High insoluble solid content (Not less than 1 %)
- Low reducing to non-reducing sugar ratio
- Full globe to tall globe shape of bulb with thin neck
- Bulbs which are resistant to diseases, pests both in field and in storge.

Points to be remember for onion dehydration

- Variety 'Bombay White' have lowest drying ratio (6:1:1) and produced the dry matter of 60.98 q/ha.
- Pusa white round can also be used for dehydration
- White onion varieties exhibit lower drying ratios than the red onions, this is because white onions have more solids
- In general, the white varieties namely pusa white round, N-257, 9-1, Pb-48, Udaipur 102, Cv. No. 36-1-3-4 and red varieties Udaipur 101, Ropali and N-53 ar best suited for dehydration.

Processing

- Onions are generally dehydrated and pickled. The ratio of raw material to finished processed product depends on the solid content of raw material, maturity at harvest, size and shape of the bulbs, deterioration in storage, and processing methods. Onions with high solid content (dry matter) are preferred for dehydration. Varieties with 15-20% TSS are the most desirable.
- Onions used for processing should have high pungency, since the dehydrated products is primarily used as a flavoring agent and some of the pungency is lost during the dehydration process. While bulbs are preferred to either yellow or red varieties.
- The pigment quercetin in yellow onion is a bitter principle with inferior flavor. For economy in field harvesting and plant preparation, large bulbs are desired for processing. The bulbs should be able to hold up in common storage for 2-3 months with a minimum of rot, shrinkage, or sprouting.

Storage

- Onions are stored in a well ventilated place with a lot of aeration and sunlight. Onions are packed in perforated gunny bags and stocked in vertical form, one above the other. However, height of such vertical column should not exceed more than 5 feet and should have sufficient space all around the bottom.
- Onion cultivars vary in their suitability for storage. Genetically controlled factors that may influence storage performance include dry matter content, pungency, skincolor, skin number and quality, and length of natural dormancy of the particular onion variety.
- The preharvest cultural factors include fertilizer and irrigation regime under which bulbs are raised and use of maleic hydrazide as a sprout suppresant before harvest.
- Physical injury during and after harvest, greening of onion due to exposure to sunlight, sprouting and injuries during storage due to ammonia, controlled-atmosphere storage, and freezing also cause postharvest losses.
- The percentage loss in white, yellow and red cultivars of dry onion stored for various periods in Guyana and red cultivars had a higher storage potential than yellow and white cultivars.
- The cultivar White Creole had exceptionally better storage characteristics. Among ten short-day onion cultivars for their storage potential and reported that Burgundy, Texas Grano (TG) 10254, and Selection 91438 had good storage potential had lost less than 35% in weight after 100 days of storage.
- Water loss contributed most to the total weight loss in Burgundy, while in TG 1105 Y and TG 1015 Y disease contributed most. Both water loss and disease contributed equally in other cultivars.
- Sprouting was also a significant factor in TG 502 and TG 1015 Y in long-term storage. It is suggested that development of onion cultivars with tightly closed neck ends could greatly reduce the storage losses in onion cultivars with high water loss and that postharvest handling should be done carefully to avoid damage to try outer

scales.

- Postharvest diseases on onion cause significant losses in the quantity and quality of onions during storage. The yeast *Kluveromyces marxianus* var. *marxianus* has been identified as a pathogen of onions in the United States.
- The symptoms, a soft rot of the bulbs, were easily confused with those of bacterial soft rot. In Australia, Cother and Dawling found seven genera of bacteria associated with onions and suggested that when physiological changes take place in onion bulbs at high temperature, some of the existing microflora usually present in bulbs can become pathogenic. Biochemical changes caused by fungal development may also allow such opportunistic bacteria to multiply.
- Mites are thought to transmit black mold between onions in store. A *Rhizoglyphus* sp. Mite in India attacks onions both in the field and in storage, reportedly leading to sprouting. Mites of this genus were also reported to be numerous on stored onions in Brazil, where they were suspected of transmitting fungal and bacterial diseases.
- Some species of beetle (*Anthrenus ocenicus, A. jordanicus,* and *Alphitobious laeviqatus*) attack stored onions in India, allowing rot-causing pathogens to enter the bulbs.

Low-Temperature Storage

- Fully matured and thoroughly cured onions are used for storage. Immature, soft, thick-necked bulbs cannot be stored for long and should be disposed of immediately after harvest.
- Through ventilation, uniform low temperature, dry atmosphere, and protection against actual freezing are essential for storing onions successfully.
- Sprouting is influenced little by the humidity but increases with increasing temperature. It was also reported that rotting increases with increase in humidity and

is little influenced by temperature. Decay increases only slightly as both temperature and humidity increases.

- A temperature of 0^{o}C and relative humidity of about 65-75% for storing onions for fresh usage. In Europe, storage of onions below the freezing point has been recommended. For this; onions are quickly cooled to 0.5 - 1.1^{o}C, and when the room is filled the temperature is lowered to -0.1 to -0.2^{o}C.
- These onions are thawed for about 1-2 weeks with the air at about 4.4^{o}C before they are removed from storage, since rapid thawing damages onions. Sub-freezing retards sprouting and is a useful alternative when sprout inhibitors cannot be used.
- Onions stored at a temperature near 0^{o}C for 150 days with no rotting or sprouting occurring during this period. However, weight loss amounted to 13%. Storage below freezing is most suitable for onions high in soluble solids intended for processing.
- Onions can also be stored at high temperatures of 29.2 - 34.7^{o}C. The storage structure used in India is shown. The external color of onions stored at high temperatures is less attractive than that of cold-stored onions; they are, however, desirable for subsequent dehydration because the dry flakes from such bulbs have better color retention.
- Temperatures of 1 and 0^{o}C and a relative humidity of 70 - 75% for storing white and red onions, respectively, for 16-20 weeks. The requirements for cold storage of onions for their efficient use in the United Kingdom, the Netherlands, and the United States have been described.

Controlled Atmosphere Storage

- The usefulness of controlled-atmosphere (CA) storage for onions has not been investigated thoroughly.

- 3-5% O_2 plus 10% CO_2 is superior to storage in air at 4.4^{o}C, but these conditions were not compared with onions stored in air at 0^{o}C.
- Low 0_2 (1%) without added CO_2 was superior to air at room temperature, but no comparison was made at temperature recommended for onions Ryall and there is little need for CA storage, since onions can be kept most of the year if stored properly.