



Postharvest Handling of Garlic in Nigeria

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Garlic (*Allium sativum*) is one of the common spice crop belonging to the family Alliaceae along with onion (*A. cepa* L.), leek (*A. ameloprismum* L.), chives (*A. schoenoprasum* L.), and shallot (*A. asaclicum*). It is the second most widely used amongst cultivated Alliums after onions (*Allium cepa*) (Ahmed *et al.*, 2007). It is a condiment that is valued for its flavor and commercial importance because of its wide medicinal value and application in food and pharmaceutical preparations (Sharma and Prasad, 2001). Globally, there is a drastic increase in the demand for garlic due to its classification as an efficient healthy food that enhances nutrition and health along with imparting taste. It possesses anti carcinogenic, microbial and insecticidal properties (Augusti 1996, Shiwani *et al.*, 2017). Valuable compounds to human health such as oligosaccharides, steroidal glycosides, essential oil, flavonoids, anthocyanins, lectins, prostaglandins, fructan, pectin, adenosine, and vitamins are found in garlic bulbs and leaves. The organosulfur compound allicin is responsible for its medicinal properties while the pungency is due to the presence of sulphur containing compound diallyl disulphide (Arzanlou and Bohlooli, 2010)

Global production: Garlic is mostly cultivated in countries across both the tropic and temperate zones. World trade in garlic is dominated by the developing countries and their share of trade has been growing at the expense of that of the developed countries during the past ten years (FAO, 2004) According to FAOSTAT 2019, the production volumes in 2019 for the top 3 countries were 23.26 million metric tonne for China, 2.91 million metric tonne for India and 466.39 thousand metric tonne for Bangladesh. Garlic production is concentrated both internationally and domestically. Spain is the highest exporter of garlic followed by China. In Africa, it is commercially grown in Egypt, Ethiopia, Algeria, Sudan, Morocco, Tunisia, Niger, Tanzania, Nigeria and Kenya. Egypt is the highest producer and exporter in Africa. Production in Nigeria is relatively low with the largest quantities being cultivated in the Northern states like Kano, Kaduna, Kebbi, Sokoto, Jigawa, Bauchi, Katsina and Zamfara States (Kudi *et al.*, 2008).

Post - Harvest Management

Many operational steps are performed in order to get matured and quality bulbs delivered from the field to the consumer. In Nigeria, about 15-50% losses occur if proper post-harvest management practices are not followed. These practices differ from place-to-place culturally. The physiological maturity of any crop at harvest has an important effect on postharvest quality of that fruit (Arah *et al.*, 2016). Therefore, care must be taken as to when to harvest the fruit in order to attain the best quality. Losses in quantity and quality occur between harvest and consumption. These losses can be attributed to poor harvesting method, rough handling, improper packaging and poor transport conditions. Proper curing, sorting and grading, transportation and storage are essential to minimize these losses. Unless these losses are curtailed, the gains from production and the potential income cannot be achieved. Post-harvest losses represent a waste of the resources – land, labour, energy, water, fertilizer, etc. that went into producing the crop. Every effort must, therefore, be made to minimize these losses.



Harvest

In order to prevent post-harvest losses in garlic storage, proper harvest timing is very crucial. Although common practice in Nigeria is to leave garlic in the ground long enough to maximize yield, it is paramount to ensure that the cloves do not start to separate from the stem, as this will reduce appearance, marketability and storability. Late-harvested garlic is more likely to have stained or partially decayed wrapper leaves and also early harvested will reduce yield, and immature bulbs might shrivel during curing. To avoid post-harvest disease in garlic storage, proper handling during harvest time should be practiced, for example avoid injury, loosen up the soil and place them carefully in the curing area. Wounds caused by bruising are another area that can easily become prone to disease which will eventually lead to postharvest losses (Gillis-Madden et al., 2020).

Drying and curing

Drying and curing are very vital steps in ensuring adequate storage period. Culturally, drying is done to remove excess moisture from outer skin and neck to prevent storage rot, while curing is a fortifying process of drying to remove the excess moisture in order to form a complete, dry, outer skin which reduces water loss and to allow the colour development and help the bulbs to become compact and go into dormant stage which suppresses incidence of disease. Curing also enhances and concentrates flavour by reducing the water content; this also reduces growth of fungal pathogens. In Nigeria, garlic farmers usually leave them for about 7- 12 days in the field for drying and this varies according to the harvesting period because garlic are harvested twice in a year. Bulbs are covered along with their tops to avoid damage to bulbs from sun. Curing is done under shade between 3-5 days, or most times they are left till the foliage turns yellow or milky in colour. Artificial curing can be done by passing hot air at 27.35°C through the curing room. It takes about 48 hours for complete curing process if humidity is between 60 - 75%. Curing in the direct sun do result in sunscald which may affect the quality of the bulbs. Also, curing in poorly ventilated areas result in large build-up of humidity, slowing the drying process and creating an enabling condition for the development and growth of microbes which will favour poor storage condition..

Sorting and Grading

In Nigeria, traditional method of sorting and grading is used and this involves the manual utilization of artisans' help. Garlic bulbs after curing are handpicked and grouped into various grade manually before their storage or marketing. The thick- necked, splitted, injured, 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 triage and decay. Brushing to remove the loose outer sheath is the final step before marketing. Garlic is usually graded by size, with the larger-sized bulbs commanding a higher price and value. In most cases, the smallest are left in the farm to spoil or they are dried and processed into the powdery form.

Packaging

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 driage loss. Garlic must be packed in such a way so as to protect the produce properly. The materials used inside the package must be new, clean and of a quality such as to avoid causing any external or internal damage to the produce. In Nigeria, garlic handlers pack them in small netted bags either for immediate sale or for transporting to other areas of the country.



Storage

In order to have a maximum storage life, garlic should be properly cured and stored at -0°C with a 60 to 70 % relative humidity. Higher humidity usually provides a conducive environment for the development of penicillin mould and root growth, which is undesirable (Madhu *et al.*, 2019). Garlic bulbs stored under ambient condition lose their stiffness or firmness, turn into elastic (spongy) and change in color because of the water loss. Dormancy of bulbs stored at temperature ranging from 5 to 18°C ends rapidly (Cantwell, 2004). Miedema (1994) revealed that the storage temperatures from 10 to 20°C initiated sprouting and Takagi (1990) included that the rate of respiration was more noteworthy at temperatures 5 , 10 , and 15°C than storage at either 0 or 20°C temperatures. Well cured and healthy garlic bulbs can be stored at temperature 0°C and relative humidity ranging from 65 to 70% for 6–7 months with low storage loss. The best temperature and relative humidity for garlic with good quality maintenance are -1 to 0C and 60–70% relative humidity and can be stored for more than 9 months under these conditions with the provision of good airflow to prevent any moisture accumulation (Cantwell & Suslow, 2002; Madhu *et al.*, 2019). Tolerable air circulation and proper storage containers are important to remove transpired heat and moisture. As storage temperatures are increased above 0°C , the rate of bulb weight loss also increases. Storage life under the mentioned suitable conditions is 6-7 months depending on the strain of garlic. Controlled atmosphere with 0.5 % of O_2 and 5 to 10 % of CO_2 can also increase the storage life of the garlic bulb.

Storage structures are crucial in maximizing of the shelf life of garlic with desirable quality. There are many local and traditional storage structures or methods at present, but most of these structures have disadvantages like lack of good ventilation facilities (Gillis-Madden *et al.*, 2020). In Nigeria, rhombus with thatched roof is commonly used for storage. They are stored individually with the tops removed. Bulbs should be stored in an uncovered or loosely covered container in a cool, dry, dark place. The flavor will increase as the bulbs are dried. Garlic can be stored in jute sacks, preferably in a mud house with a thatched roof. It is not advisable to freeze garlic because it changes its texture and reduces its flavor profile.

Transport

The bulbs must be thoroughly dried before being shipped or transported. The moisture content is very important before transportation as it greatly affects the quality of the bulb. It is also advisable to have refrigerated transport vehicles if the garlic bulbs are to be transported to distant destinations. In Nigeria, garlic are commonly transported in open lorries or vehicles without the use of refrigerated vans thereby increasing the post harvest losses value.

Marketing

Presently in Nigeria, majority of garlic is marketed as fresh product to the fresh produce markets throughout the year. The market prices are greatly influenced by the supply and so called middle men who are the determining factor in most agricultural produce in the country. When the garlic crop is scarce then the prices are high. Comparing with other allium vegetable in the market, Garlics are mostly more expensive because of the production level in the country.

Postharvest Problems

The garlic may undergo several problems during its storage, such as bud sprouting and fork developing, diseases like blue rot or soft rot, and the attack of determined pests, being insect larvae or acari. The development of buds and roots may occur, 2 or 3 months after the harvesting. At the beginning it is a very slow process, although after some time it speeds. Temperatures between 5 and 10°C favour the sprouting, whereas the inferior and superior temperatures inhibit it. The high levels



of moisture also facilitate this problem, although if they are too low, the bulb dehydrates (Howard *et al.*, 2008).

Conclusion

Garlic is a vital crop used in adding flavour to various dishes. Quality of stored garlic deteriorates in storage especially at ambient conditions, so the role of post-harvest management of the horticultural crops arises here. Therefore, the main focus should be on ways to prevent the spoilage and have maximum utilization of the crop in a nutritious and safe manner. In Nigeria, much attention is not attached to post harvest handling of this special crop despite its high percentage loss. Furthermore, efforts by different relevant stakeholders should be geared towards its maximum loss prevention.

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