

EFFORTS TOWARDS THE REDUCTION IN POST-HARVEST LOSSES OF CABBAGE**Paul K. Wahome****Department of Horticulture, Faculty of Agriculture, Luyengo Campus, University of Eswatini, Private Bag Luyengo, M205, Eswatini****Email address: wahome@uniswa.sz****Abstract**

For a profitable cabbage production, growers should reduce losses in the field, enhance quality and safety of the produce after harvesting, and supply the produce at its best possible condition to the consumers. After harvesting, the quality of produce usually cannot be improved, but can only be maintained. The most basic factor affecting good quality is harvesting at proper stage of maturity. The most important quality characteristics of fresh market cabbage are colour, firmness, crispness, and freedom from decay and rot. High temperatures during post-harvest period and the use of non-protective packages are the major sources of high level damage and deterioration, which greatly reduces the potential post-harvest life of all fresh produce including cabbage. Assessing post-harvest losses of fresh produce provides benchmark information for determining loss reduction interventions to increase profitability and competitiveness of farming and marketing ventures. The most common post-harvest problems of cabbage in the supply chain are physical damage, bacterial soft rot, leaf yellowing, and wilting. Storage of cabbage at 4-10°C, can effectively delay leaf yellowing and maintain leaf chlorophyll content. Low temperature or cold storage is the single most effective method of prolonging the post-harvest life of fresh produce. Weight loss, respiration rate and ethylene production can also be reduced at low temperatures and the head firmness maintained. In many developing countries, the fresh produce industry is hampered by lack of efficient and effective supply chains. The supply chains are generally not organised, are fragmented, and losses in product quality and quantity are usually high, which are absorbed by farmers as reduced farm-gate price and by consumers as increased purchase price.

Keywords: Cabbage, post-harvest disorders, post-harvest handling, post-harvest loss control, post-harvest losses.

INTRODUCTION

Provision of technological and market support to intensify cabbage production and marketing can contribute significantly in achievement of food security, alleviation of poverty, and improvement in rural economy especially in developing countries. Most cabbages are produced by smallholder farmers. It is necessary, therefore, to improve production and marketing efficiencies especially among the smallholder growers to reduce their vulnerability to marginalisation in the face of market globalisation due to their low productivity, poor quality produce, and limited markets (Thongsavath *et al.*, 2012).

According to Muchara *et al.* (2015), few economic activities exhibit the degree of complexities, inter-linkages and multi-stakeholder process as vegetable production and its

associated sub-fields such as processing and marketing. Enhancement of market access plays a very crucial role in livelihood improvements and poverty reduction. Value chains can contribute in understanding of the complex interactions involved and how these can be manipulated for the benefit of the small-scale farmer.

According to Champa *et al.* (2007), the major causes of post-harvest losses in cabbage are harvesting at an over-mature stage that is indicated by head cracks and due to mechanical damage caused by rough handling during harvesting and poor packaging in polyethylene sacks. Mechanical damage that takes place in poly-sacks during distribution can result in cabbage head cracks and cuts through which moisture can be lost and also form avenues for the entry of rotting microbes.

The most critical stage in the post-harvest system that leads to serious quantitative and qualitative losses is harvesting (Champ *et al.*, 2007). This is the starting point for the post-harvest management process. After harvesting, the quality of produce usually cannot be improved, only can be maintained (Champ *et al.*, 2007). The most basic factor affecting good quality is harvesting at proper stage of maturity. Most cabbage cultivars generally mature within 62 to 110 days after transplanting in low altitude and 81 to 125 days in high elevations (Champ *et al.*, 2007). The most important quality characteristics of fresh market cabbage are colour, firmness, crispness, and freedom from decay and rot (Champ *et al.*, 2007). Early harvesting will result in loose unfilled heads while late harvesting may result in cracked or rotted heads.

HARVESTING

According to the Caribbean Agricultural Research and Development Institute (CARDI) (2010), harvesting is one of the most costly operations in getting produce to the market. If harvesting is done incorrectly, money will be wasted, because the quality of the produce will be poor when it reaches the market. Harvesting produce at the correct stage of maturity is very important for several reasons, which include different markets often require produce at different stages of maturity; the journey time from farm to the market also affects the stage at which the crop should be harvested; many types of produce will not ripen properly or will have poor taste if harvested too early; and if harvested too late, it reduces the shelf-life.

The time of the day at which the crop is harvested will also affect its final quality. Produce should be harvested in the cooler hours of the day, preferably early in the morning. This prevents produce getting too hot, reducing water loss and spoilage. It is necessary to avoid harvesting in the rain because excessive moisture increases rotting. Produce can be severely damaged during harvesting, if it is done incorrectly. By using appropriate harvesting tools and handling the crop carefully, quality can be improved.

According to Ministry of Fisheries, Crops and Livestock (2004), the principle harvest maturity index for cabbage is based on size, head compactness and firmness to touch. A very loose head is immature and should not be harvested. Delaying harvesting of cabbage even for a few days beyond maturity can result in split heads and increased pressure of diseases, especially in wet weather. Ideally, plastic field crates should be used for handling produce during harvesting. These provide good protection to produce. They should have sufficient holes for ventilation, which cools the produce and allows it to respire.

Harvested cabbage is particularly susceptible to wilting and should be removed from the field and direct sunlight as soon as possible (Ministry of Fisheries, Crops and Livestock,

2004). It should be taken to a well-ventilated shaded area for packaging and transportation to the market. When there is a delay of more than an hour or two between harvest and packing, a spray of clean water to the leaves can help prevent dehydration. A simple field packing station can be constructed from wooden poles and a sheet of polythene. Thatch over the roof will provide shade and keep the station cool.

POST-HARVEST HANDLING

Cleaning

The first step in preparing cabbage for the market is to remove the torn and loose outer wrapper leaves so the head is clean, compact and fresh in appearance (Ministry of Fisheries, Crops and Livestock, 2004). Only three to six tight wrapper leaves should be left on the head. Loose leaves interfere with ventilation between heads. The stem end should be trimmed so it does not protrude more than 2 cm. A fresh cut of the stem end may be necessary if it is discoloured.

Sorting and grading

During grading, damaged and diseased wrapper leaves of cabbage should be removed. Heads with insect damage, freezing damage, sunscald, and bruising should be discarded. Cabbage should be graded according to size (small, medium and large), shape, and compactness of the head. According to Ministry of Fisheries, Crops and Livestock (2004), there are three size categories [small (0.8 kg or less), medium (0.9-1.4 kg) and large (1.5 kg or more)] based on the weight of the head.

Packaging

Normally, cabbage is sent to the market loose or sometimes it is packaged in gunny bags. However, it is advisable to pack it in baskets or crates to reduce damage in transit. Cabbage is normally packaged in fibre-board cartons, wooden or wired-bound crates, or mesh bags. Cartons and crates are easier to stack and load and provide considerably more protection to the cabbage than mesh bags (Ministry of Fisheries, Crops and Livestock, 2004).

Storage

Cabbage should be dispatched to the market immediately after harvesting and grading. Only cabbage with solid heads with no yellowing, decay or mechanical injuries should be stored. Before storage, all loose leaves should be trimmed away leaving heads with not more than six tight wrapper leaves. For storage up to 3-6 weeks, the optimum temperature of storing is 0°C with a relative humidity of 95%.

POST-HARVEST LOSSES IN CABBAGE

Causes of post-harvest losses

According to Department of Agriculture and Fisheries (2015), post-harvest losses starts first from the field, after harvesting, in grading and packaging areas, in storage, during transportation, and in the wholesale and retail markets. Several losses occur because of poor facilities, lack of know-how, poor management, market dysfunction or simply the carelessness of farmers. Horticultural produce typically have high moisture content, tender texture and highly perishable. If not handled properly, a high-value nutritious product can deteriorate and rot in a matter of days or hour. The major causes of post-harvest losses include metabolic: natural process of respiration involving the breakdown of food reserves and aging of these organs; mechanical: owing to their tender texture and high moisture content, fresh produce are susceptible to mechanical injury. Poor handling, unsuitable containers, improper packaging and transportation can easily cause bruising, cutting, breaking, impact wound etc.; diseases: high post-harvest losses can be caused by the invasion of fungi and bacteria. These micro-organisms attack fresh produce easily and spread quickly, because the produce lack natural defence mechanism and has plenty of nutrients and moisture to support microbial growth; physiological deterioration: physiological disorders may occur due to mineral deficiency, low or high temperatures, undesirable atmospheric conditions, such as humidity, ethylene accumulation etc. enzymatic actions may also lead over-ripeness and senescence of produce; lack of market: poor planning, inaccurate production and market information may lead to overproduction of produce, which cannot be sold in good time. Inadequate transportation and storage facilities can also result in heavy losses of produce; and consumption: losses may occur due to inadequate preservation methods at home, methods of cooking and preparation such as peeling, consumption styles etc.

Post-harvest diseases

According to Ministry of Fisheries, Crops and Livestock (2004), storage diseases can be minimised by using clean and sharp cutting knives, careful harvesting and handling practices to prevent wounding of leaf tissue, trimming-off infected outer leaves, followed by storing at 0°C. Most common post-harvest diseases in cabbage include bacterial soft rot ((*Erwinia*, *Pseudomonas* and *Xanthomonas*): infected tissue quickly decays and turns into a soft, slimy, foul-smelling mess at ambient temperature. Development of bacterial soft rot at the cut stem end can be prevented by spraying 15% aluminium potassium sulphate or lime powder. Care should be taken avoid injury during harvesting and handling; phytophthora rot (*Phytophthora porri*): fungus is soil-borne and it is most severe during rainy season under poorly drained soils. Symptoms typically begin as a dark brown rot at cut stem end and gradually progresses to the cabbage head. The decayed stem produces a distinct sour odour. The disease can also be spread by contaminated cutting knives; rhizoctonia rot (*Rhizoctonia solani*): it is a soil-borne fungus. It is spread through contact between

cabbage head and soil. Favoured by wet weather conditions. Symptoms begin as sunken black lesions on lower leaf midribs in contact with soil. As decay progresses, a dark mould spreads over the leaves. It can be controlled by storing cabbage at cool temperatures, below 10°C; grey mould (*Botrytis cinerea*): it is commonly found on stored cabbage grown under wet conditions. The fungus is persistent in soil, on crop debris and in unsanitary storage facilities. Symptoms appear as brown water-soaked areas on the outer surface. Under humid storage conditions, a whitish mould develops, which eventually darkens into a brownish-grey mass. Grey mould can be minimised by rapid cooling of cabbage after harvesting and storage at 0°C; dark leaf spot (*Alternaria brassicae*): infection usually begins prior to harvest although symptoms may not be apparent. It starts as small dark spots on outer leaves. The spots gradually enlarge at ambient temperatures and produce dark spores. Decay can be slowed by cold temperature storage; and watery soft rot (*Sclerotinia sclerotiorum*): It is common in cabbage produced from poorly drained soils or during the rainy season. Symptoms appear as water-soaked spots on outer leaves. The spots eventually coalesce into a leaky grey soft tissue mass. In contrast to bacterial soft rot, there is no odour in this case. Disease can be controlled by sanitation.

Post-harvest disorders

Quality of cabbage can be compromised by post-harvest disorders, which include yellowing: storing cabbage at ambient temperature will result in a gradual loss of green chlorophyll pigment and yellowing of the outer leaves. Cabbage is also sensitive to ethylene, which causes leaf yellowing and leaf shedding. Adequate ventilation is important to prevent accumulation of ethylene. In addition, cabbage should not be stored in close proximity with fruits that emit high amounts of ethylene; and black leaf speck (pepper speck): symptoms begin with the development of individual specks, randomly distributed over the leaf. Specks develop further in storage and unite to form large spots. The black specks results from discolouration and collapse tissue surrounding the stomata in the leaves. Symptoms can often be seen well into the centre of the head. It is believed to be caused by high rates of fertiliser application and cultural conditions that promote vigorous growth. High potassium application rates tend to reduce severity of the condition (Ministry of Fisheries, Crops and Livestock, 2004).

Post-harvest care of cabbage

Cabbage should always be removed from direct sun after harvesting and transported to the packing house/shed immediately. When there is a delay of more than one or two hours between harvesting and packaging, a water drench or spray arrangement can help prevent dehydration and overheating (Department of Agriculture and Fisheries, 2015). The optimum storage temperature for cabbage is 0°C and relative humidity of 90-95%.

Assessing post-harvest losses of fresh produce provides benchmark information for determining loss reduction interventions to increase profitability and competitiveness of farming and marketing ventures (Gonzales *et al.*, 2015). According to Kramchote *et al.* (2012), leaf yellowing and wilting are the most common post-harvest problems of cabbage in the supply chain. Storage of cabbage at 4-10°C, can effectively delay leaf yellowing and maintain leaf chlorophyll content. Weight loss, respiration rate and ethylene production were also reduced at low temperatures and the head firmness was maintained. Moreover, total soluble solids and ascorbic acid contents were also higher under low temperatures as compared to those in cabbage stored at ambient temperature. Cabbage can be stored successfully at 4°C for 18 days and 12 days at 10°C. At ambient temperature cabbage deteriorated rapidly and lasted for only a few days.

Green coloured cabbage heads are preferred by traders and consumers. Poor handling consequently results in significant product losses. In some cases, cabbage reaches the retail market at least one or two days after harvest, thus, quality will have significantly decreased. According to Kramchote *et al.* (2012), low temperature or cold storage is the single most effective method of prolonging the post-harvest life of fresh produce. It reduces respiration rate, ethylene production and sensitivity, moisture loss, and growth of pathogens. Its integration in cabbage supply chain management could improve profitability and sustainability.

Gonzales *et al.* (2015) observed that cabbage has to be transported over long distances from the production areas to the market. Poor handling consequently results in significant product losses. The high perishability of cabbage exacerbates the problem. To effectively reduce post-harvest losses, it is always recommended to pursue a supply chain approach in which the whole supply chain is considered in determining appropriate interventions, in contrast to the piecemeal approach in which only one stage in the supply chain is being targeted for intervention. In many developing countries, the fresh produce industry is hampered by lack of efficient and effective supply chains. The supply chains may be generally not organised, are fragmented, and losses in product quality and quantity are usually high, which are absorbed by farmers as reduced farm-gate price and by consumers as increased purchase price.

The extremely perishable nature of cabbage results in inability on the part of producer to manage supply to the market. Furthermore, the long distance that separate the production area and the sub-optimal post-harvest technology management (harvesting, grading, packaging, storage, and transportation), a large proportion of cabbages produced is lost or spoiled at various stages of the supply chain. Severe losses occur due to poor transportation facilities, lack of knowhow, poor management and improper market facilities

or due to careless handling of the vegetables by farmers, market intermediaries and consumers (Ramchandra *et al.*, 2015; Thongsavath *et al.*, 2012). According to Ramchandra *et al.* (2015), well managed post-harvest practices for vegetables leads to higher yields and profits to producers.

Control of post-harvest losses

According to Saran *et al.* (2012), post-harvest losses in fresh produce can be greatly reduced by improved containers or packages: plastic crates, liners for existing rough packages, and use of small packages; improved field packaging methods during harvesting; providing shade to harvested produce by covering using cloths, plastic nets, and simple sheds; insect pest management: hot water dip, waxing, edible films application, forced hot air, insecticide impregnated films, carbon dioxide fluxes, use of dry ice, etc.; low cost cooling: evaporative forced air cooling, hydro-cooling etc.; cold-storage of harvested produce (evaporative cool storage chambers, solar or wind powered low-energy structures); cold-transportation of fresh produce; improved, low-cost, low-technology food processing systems, e.g. sun drying of produce, use of safe food additives and preservatives, etc. and; sanitation: hand washing, washing produce with chlorinated water etc.

CONCLUSION

Horticultural producers operate within an environment characterised by existence of a sophisticated logistical chain between the producer and the consumer. Cabbage producers in most developing countries rely mainly on informal markets for their product and the level of formal market is very low. Government development programmes in developing countries should promote cooperation in order to improve the level of efficiency in the horticultural marketing chains. This is important for buyers of vegetables seeking to improve quality by establishing closer, more directed relationship with suppliers.

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