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Research Paper

Evaluation of market-level storage structures and postharvest losses of selected fruits and vegetables: A case study of five markets in Ibadan

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Abstract. Although several measures have been adopted to enhance food storage in sub-Saharan Africa, postharvest losses continue to increase. Addressing the negative trend requires up-to-date information on current practices by agro-allied personnel involved in the postharvest handling of perishables to proffer effective solutions. This study explored the level of postharvest losses in fruits and vegetables in five markets in Ibadan, Nigeria. The proportionate sampling technique was employed to collect data from 235 sellers in the markets using a questionnaire. The percentage of grade loss in the supply chain was classified as bruises, mold, and rot. It was revealed that the quality of about 89.2% of the fruits and vegetables degrade during and after transportation. Storage conditions which include keeping the produce on a wooden platform, on the bare floor in stalls, and storage in non-ventilated enclosed rooms remain crude and this also contributes to losses incurred. Improvement and maintenance of road infrastructures, the establishment of improved storage facilities and the introduction of modern storage technologies would be recommended for reducing postharvest losses of fruits and vegetables in markets of Ibadan.

Keywords: Market-level storage, fruits, vegetables, postharvest losses, storage structures.

INTRODUCTION

Fruits and vegetables have a high nourishing value. They are the main sources of vitamins and minerals, thus, necessary nutritious foods (Babalola *et al.,* 2010; Vincente *et al.*, 2014, Arah *et al.*, 2015). Fruits and vegetables in their fresh forms contain a high proportion of water and they cover a wide range of produce that differ much in perishability after harvest. They are generally more perishable than root and tuber crops and invariably much more perishable than grains. According to the Food and Agricultural Organization (FAO) 2011, fresh fruits and vegetables are naturally more liable to deterioration under hot conditions characterized by high ambient temperatures and humidity, and a high incidence of pests and diseases, which are typical features of the humid tropics. They are generally known as perishables due to their natural shelf life, and many problems arise in handling these agricultural products, a setback that has affected farmers for years. Postharvest handling of perishables, therefore, requires proper management as deterioration sets in soon after harvest (Adeoye, 2009).

Mbuk *et al.* (2011) defined postharvest handling as the stage in the value chain of crop production immediately after harvest, which includes storage, cleaning, packing, transportation, and sorting. Furthermore, they noted that of utmost importance in postharvest management is the keeping of produce cool enough, avoiding moisture loss, as well as avoiding physical damage to produce. Many problems affect the marketing of these farm products among which are, the seasonality of production, high perishability, the bulkiness of products, storage and

labour costs as well as the initial quality of the products (Yusuf *et al.*, 2012).

Lipinski *et al.* (2013) described food loss and waste as the edible parts of plants and animals that are produced or harvested for human consumption but that are not ultimately consumed by people. Furthermore, they described food loss as food that spills, spoils, suffers an abnormal reduction in quality, or in any way gets lost before reaching the consumer. Losses as high as 50% are often reported in fruits and vegetables in sub-Saharan Africa usually due to biological, chemical, physiological, and mechanical factors (Aworh, 2005; Atanda *et. al.*, 2011; Affognon *et al.*, 2015).

Postharvest losses of fruits and vegetables are difficult to estimate except on a limited, measured experimental basis (Idah *et al*., 2012). These losses occur during transportation, storage, and marketing (Naureen *et al.*, 2009). Worldwide, postharvest losses of fruits and vegetables are as high as between 30-50% and even much higher in some developing countries (Kitinoja and Kader, 2015). In sub-Saharan Africa, even though the precise quantity of the loss of food between harvest and consumption is unknown, losses in fruits and vegetables are estimated to be as high as 60% of total production (Kader, 2005). Reducing postharvest losses is necessary to ensure sufficient food is available both in quality and quantity to every person. Moreover, postharvest loss reduction reduces the cost of production, may influence price reduction for consumers, and increase the farmers' income.

The quantity of produce available to consumers is of great importance compared to the level of production. The Food and Agricultural Organization (FAO) 2011 describes the loss of foods in the post-harvest system as not new since it has always been a problem for humankind. Moreover, considering the rapidly growing population in the poorest countries of the world where food is already in short supply, there is an increasing urgency on ensuring postharvest loss reduction in the food supply chain to lessen hunger and undernourishment (Atanda et. al, 2011). While it is known that postharvest losses of fruits and vegetables are more serious in developing countries than in well-developed ones (Kitinoja and Kader, 2015), it has been a far-reaching misery to food sufficiency in Nigeria even though there is increased crop production.

The financial implications of postharvest losses of fruits and vegetables in Nigeria cost billions of Naira annually and these losses do not only affect the output but also decrease farmers' income all over the world (Obayelu, 2013, Abass *et al.*, 2018). Postharvest losses especially in fruits such as citrus, banana, and pineapple are enormous because the marketing structure of these fruits causes about 75% of the burden of these losses in fruit markets. Fresh fruits and vegetable supplies have individual requirements concerning temperature and other factors that must be provided for safe handling and storage. The FAO, 2021 reported that global production of fruit rose to 868 million tons, while that of vegetables reached about 1089 million tons in 2018. The consequences of these losses include food insecurity, higher food prices, and ultimately loss of scarce resources used in production. Postharvest losses and food wastage in the postharvest value chain are receiving increased attention and policies are being planned to reduce these losses.

It has been projected that the global population will rise to 8.3 billion in 2025 (Folmer *et al.*, 2013). Therefore, minimizing postharvest losses is very essential because it will ensure adequacy in food supply both in quantity and quality (Kiaya, 2014). Traditional methods of storage are a type of knowledge, which has evolved into the community and has been passed on from one generation to another generation (Parmar and Jain, 2016). Storage practices differ and there are small or big storehouses, indoor or outdoor, temporary or permanent and individual or community storage design. In Nigeria, the prominent structures found in the different climatic zones are; granaries, mud, rhombus, thatched rhombus, platforms, cribs, earthen pots or baskets, domestic or indoor storage media such as plastic containers, gourds and metal containers. Bags made from jute, hessian, polyethylene or plant fibre material could be used as a storage media (Nduku *et al*., 2013).

Farmers and traders tend to spread the cost of production on the price of the good ones thereby increasing the market price (Olayiwola, 2012). For instance, grade loss during transit has been widely reported when perishables are transported from Northern Nigeria to the southern parts due to the interrelation of factors such as microbial, physiological and mechanical. (Idah *et al.*, 2007; Mbuk *et al.*, 2011). Also, the extent of losses that occur among wholesalers and retailers due to the lack of appropriate facilities is severe. This study set out to evaluate the types of market-level storage structures available in Ibadan, Nigeria, as well as postharvest losses in fruits and vegetables based on first-hand information from sellers, using five markets in the Ibadan metropolis as a case study.

METHODOLOGY

Based on previous experience, the major markets involved in the distribution of fruits and vegetables in Ibadan, Oyo State, Nigeria either as wholesalers or as retailers were identified. All available and relevant information about the target markets was gathered. Based on the findings, markets in Oje, Bodija, Ojoo, Sasa, and Orita-merin were selected for a thorough survey as these were found as major distribution points for fruits and vegetables transported from different parts of Nigeria. Data on the actual number of sellers in each market was collected from the leaders of each market.

Table 1. Demographic distribution of the respondents.

Variables	Number of respondents	Percentage (%)
Market Location		
Bodija	50	21.3
Sasa	60	25.5
Oja Oba	35	14.9
OJE	50	21.3
ORITA	40	17.0
Total	235	
Gender		
Male	106	45.1
Female	129	54.9
Total	235	100.0
Age distribution		
Below 20	2	0.9
20-29	68	28.9
30-39	35	14.9
40-49	126	53.6
50-59	4	1.7
Total	235	100.0
Junior sec	39	16.6
Senior sec	119	50.6
Tertiary	30	12.8
Non-formal	18	7.7
Pry	29	12.3
Total	235	100.0
Single	113	48.1
Married	117	49.8
Widow	5	2.1
Total	235	100.0
Christianity	78	33.2
Islam	147	62.6
Others	10	4.3
Total	235	100.0
Yoruba	110	46.8
Igbo	41	17.4
Hausa	84	35.6
Total	235	100.0

Proportionate sampling was used to select the total number of wholesalers and retailers to be interviewed and fifty percent (50%) of identified fruit wholesalers and retailers in each market were selected for the study. Data collection employed questionnaires and personal interviews with the help of trained research personnel. Data were analyzed using Statistical Packages for Social Sciences (SPSS Version 23) on simple percentages.

RESULTS AND DISCUSSION

Findings from this survey are presented as follows:

Socio-demographic distribution of the traders

Table 1 shows the socio-demographic distribution of the traders. Bodija, Sasa, Oja-oba, Oje and Orita-merin contributed 21.3, 25.5, 14.9, 21.3 and 17.0% of the total respondents respectively. It was observed that 45.1% of the traders were males while 54.9% were female, establishing a general notion that there are more female workers in agro-allied retail trade than males (Glopolis, 2012). However, fruits and vegetables marketing business are mostly done by people between ages 40-45 years (53.8%) while ages below 20, 20-29, 30-39 and 50-

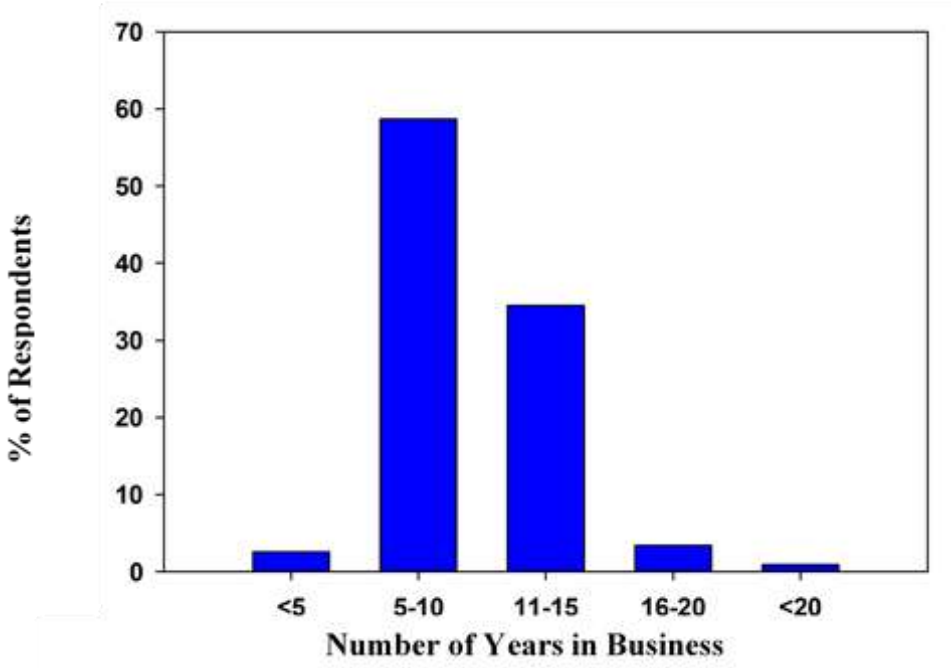

Figure 1. The number of years of experience of respondents.

59 years have a population distribution of 0.9, 28.9, 14.9 and 1.7%, respectively.

People with secondary school education were more in the trade of fruits and vegetables and as the level of education among respondents were non-formal, primary school certificate, junior secondary school certificate, senior secondary school certificate and tertiary at 7.7, 12.3, 16.6, 50.6 and 12.8% respectively. Out of this, 48.1% were single, 49.8% were married and 2.1% are widowed. The largest religion among these traders is Islam (62.6%) followed by Christianity at 33.2%. As for the ethnicity of the traders, the diversity shows that Yorubas were dominant with 46.8%, followed by Hausa (35.6%) and Igbo (17.4%).

Socio-economic activities of the traders

There were more wholesalers (89%) of fruits and vegetables than retailers (37.9 %) in all the markets. Specifically, Sasa, Oje, and Bodija are major markets where farmers sell their fruits and vegetables directly to the retail buyers and it was deduced that wholesale buyers dominate these three. Furthermore, some of the buyers and sellers (0.9%) of fruits and vegetables have been in this business for more than two decades while 2.6, 58.7, 34.5 and 3.4% of the traders have been in this business for less than 5, 5-10 years, 11-15 years and 16-20 years respectively as showed in Figure 1.

The monthly income of 74.9% of these traders was between ₦41,000 to ₦60,000 while only about 2.6% of respondents earn about ₦100,000 monthly as shown in Figure 2.

The type fruits and vegetables traded in the study locations are tomatoes (8.5%), pineapples (15.7%), plantain (44.3%), watermelon (10.6%) and others such as pepper, tangerine and leafy vegetables (20.9%) as shown in Figure 3. The availability of these commodities varies depending on the season. For instance, the most traded fruit during the study was plantain. Moreover, 20.9% of other fruits captured in Figure 4 include oranges, pawpaw, African apple and apples. Furthermore, volume of trade varies from trader to trader, with the greater percentage of 41.3% buying in bulk once a month as shown in Figure 4.

The traders used various transportation infrastructures mainly roads (55.7%), which include Federal, State and footpaths as shown in Figure 5. Supplies are sourced mainly from Northern and Western parts of Nigeria at 32.3 and 55.3% respectively, and 12.3 % are from other parts of Nigeria (Figure 5). Some of the vehicles used by the traders to transport their goods are shown in Figure 6; with the preferred choice being the trailer (43.8%), especially for tomatoes and peppers (Figure 7). Most of the respondents, about 64.7%, agreed that the condition of the roads is bad as shown in Figure 8. Bad roads lead to a high cost of transportation and increase the likelihood of the fruits becoming damaged.

Losses before and after transportation

According to respondents, about 26.8% of the products

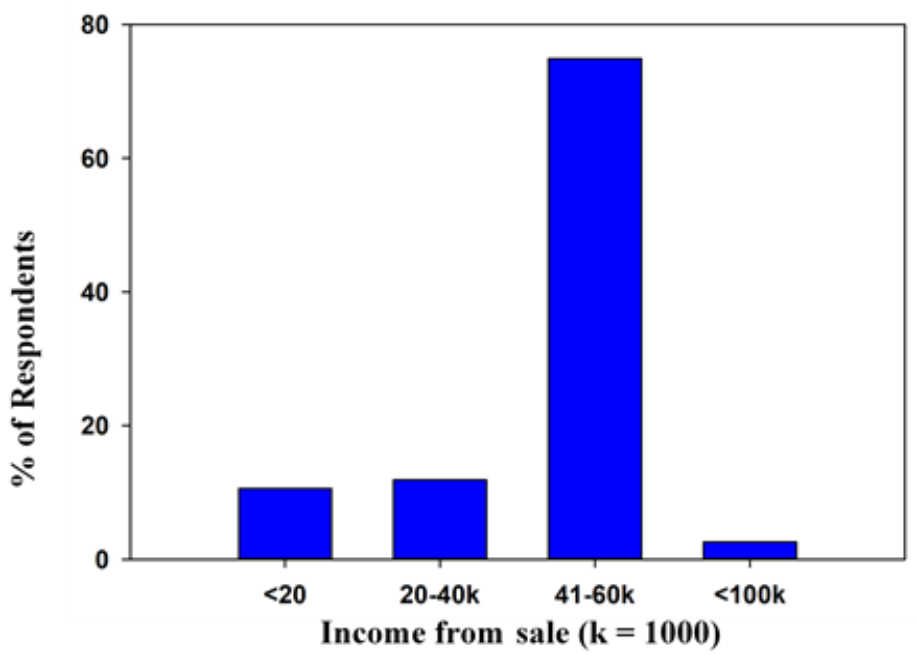

Figure 2. Traders monthly income.

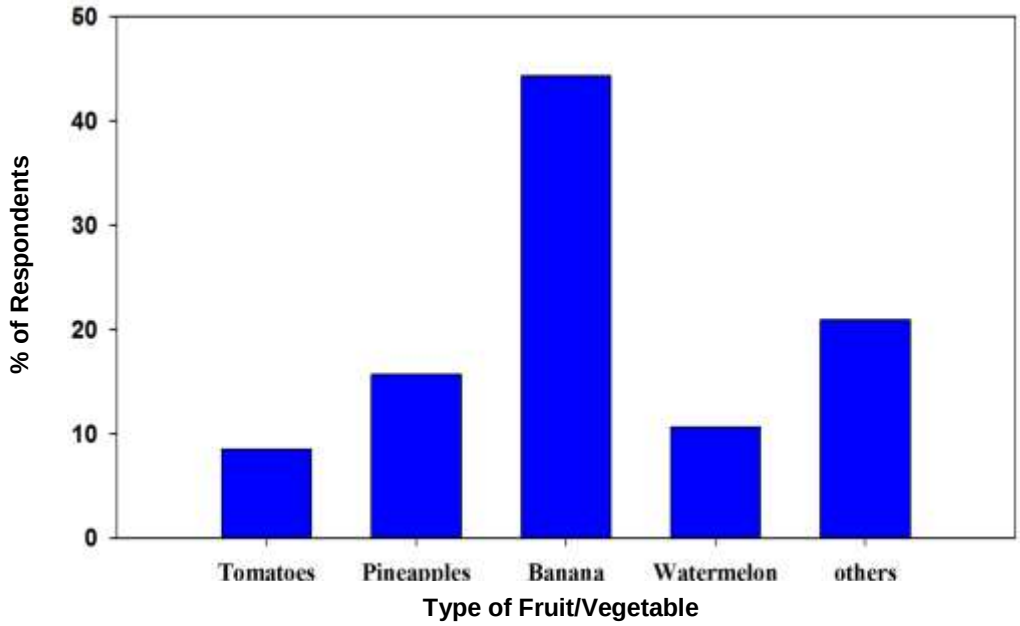

Figure 3. Quantity of fruits sold at the study locations.

purchased are already spoilt before transportation while 73.2% are in good condition as shown in Figure 9. However, about 62.6% of the products also suffer grade loss by the time they reach the markets. Moreover, traders reported that outright loss can be as high as 89.2% of products are not sold quickly enough as shown in Figure 10. This is a huge loss that should be curtailed. Similar findings were reported by Adeoye (2009).

Handling and transport systems as sources of postharvest loss

Various packaging materials are used in transporting fruits and vegetables (Figure 11). Among the respondents, about 8.9% use sacks, 26% use plastic bowls/containers, 0.4% use trays, 58.7% use baskets and others such as plastic and nylon accounted for 6%.

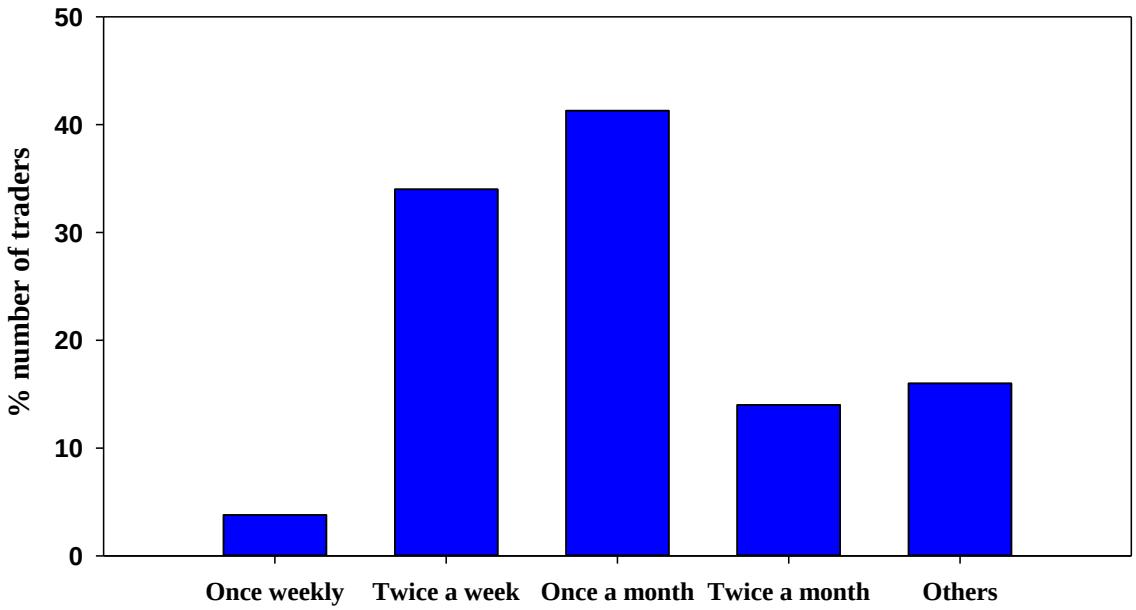

Figure 4. Frequency of bulk purchase (fruits and vegetables) by the traders.

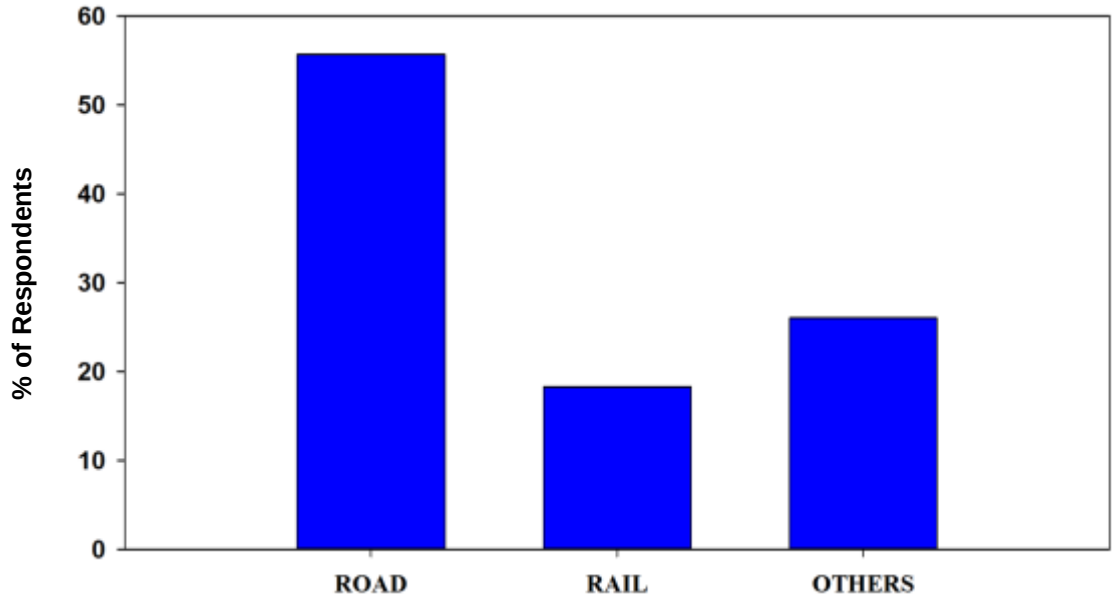

Figure 5. Means of transportation used by traders.

Choice of handling or conveyance medium depends on the type of fruit or vegetable being sold. Many of the traders who use baskets are involved with the trade of peppers, oranges and tomatoes which many times, bruise the fruits and create opportunities for deterioration. Most of the time, the loading systems impose a direct impact on the crops. In addition, Figure 11b shows the pattern of loading products during transport and it is evident that some losses are incurred due to these loading patterns. While about 26% of respondents load products directly on each other without any conveyance medium, others do what is known as “multi-layered loading” in which the carriage of a truck is divided into two sections using planks or other similar load-bearing materials. The first layer of products is laid upon the bed of the truck, while the second layer is placed on the planks. This is done to reduce the load on products at the lower layers of the truck, thereby preventing further mechanical damage. Mass stacking refers to the use of transport media such as baskets which are stacked

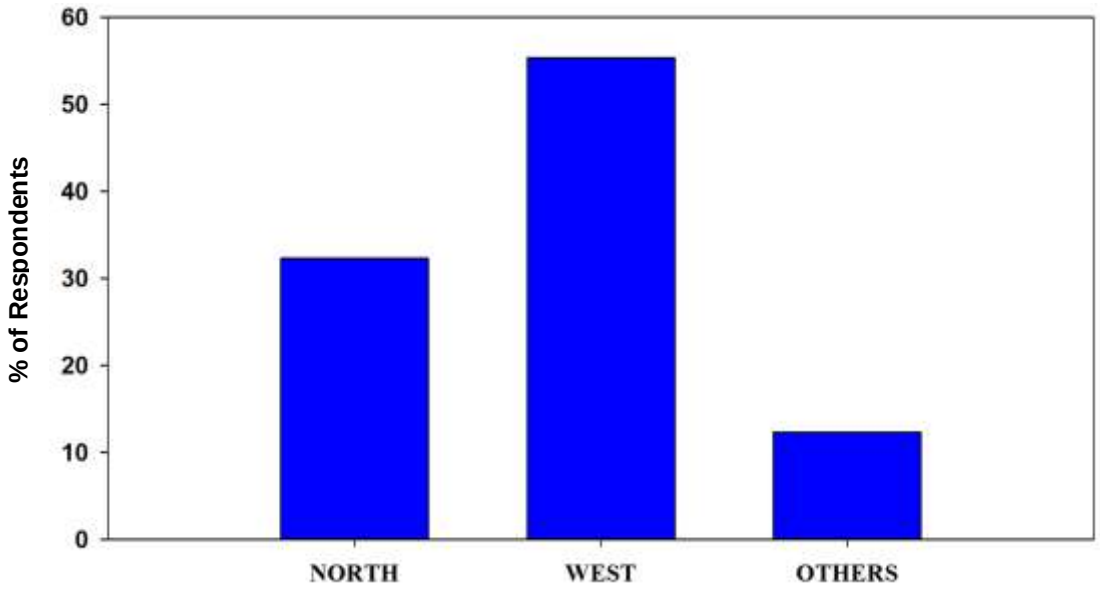

Figure 6. Source of the product (part of the country from which fruit/vegetable was bought).

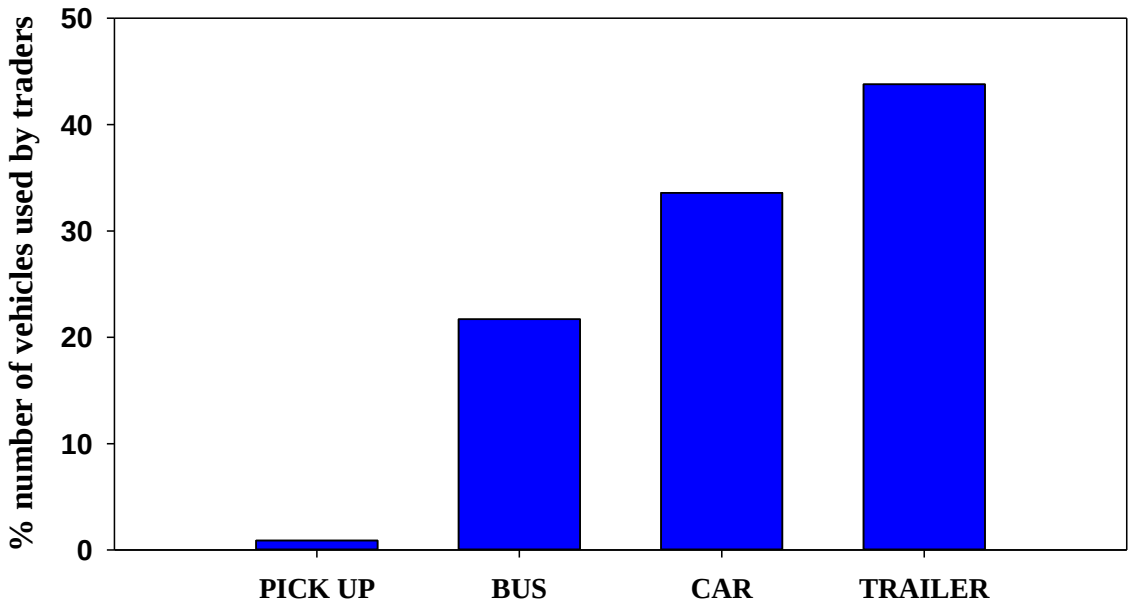

Figure 7. Type of vehicles used for transporting perishables.

directly on each other. Significant damage to products is recorded from products placed at the bottom.

Furthermore, Table 2 shows that 41.3% of the drivers place other loads on the fruits they carry thereby causing further damage and grade loss to the commodities. Moreover, 28.5% of the traders reported that they do not offload products immediately after transportation (Table 3), which may further increase the chances of deterioration in product quality. Thus, traders confirmed that losses are also experienced during the packing and loading of products.

Damages and losses during fruits and vegetable purchase

Respondents also mentioned cases of poor-quality products procured from farmers and aggregators. As shown in Figure 12a, 81.3% of the respondents reported that less than 10% of produce purchased is already damaged at the source. About 55.7% of respondents also reported observing black blemishes on about 10% of fruits such as tomatoes as shown in Figure 12b. Furthermore, about 49.8% of respondents reported that

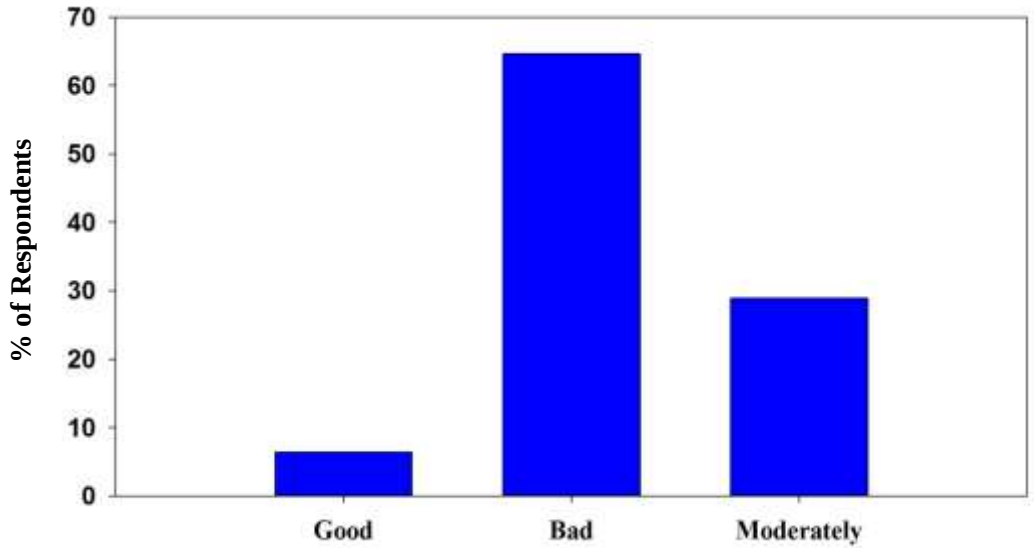

Figure 8. Perception of respondents on conditions of the road used for transporting fresh commodities.

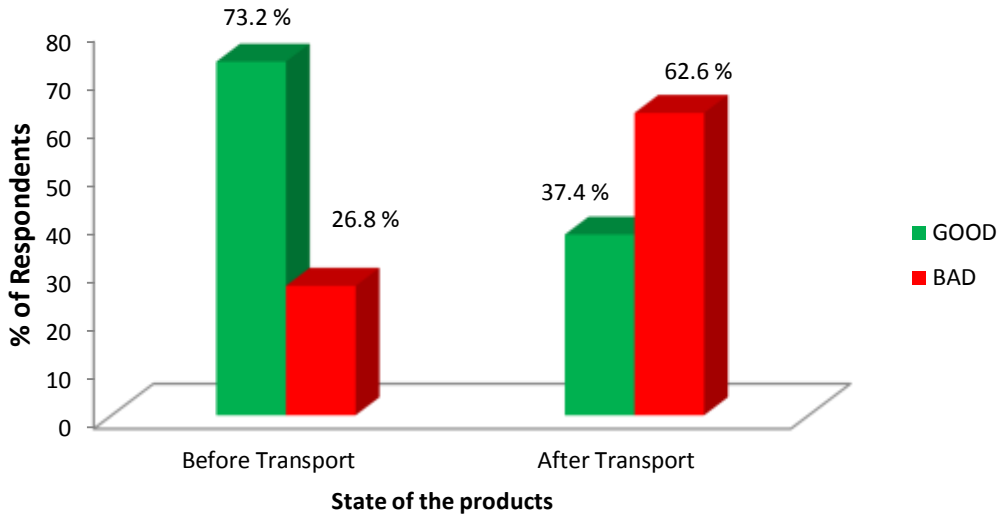

Figure 9. Stages of losses of perishables in the supply value chain.

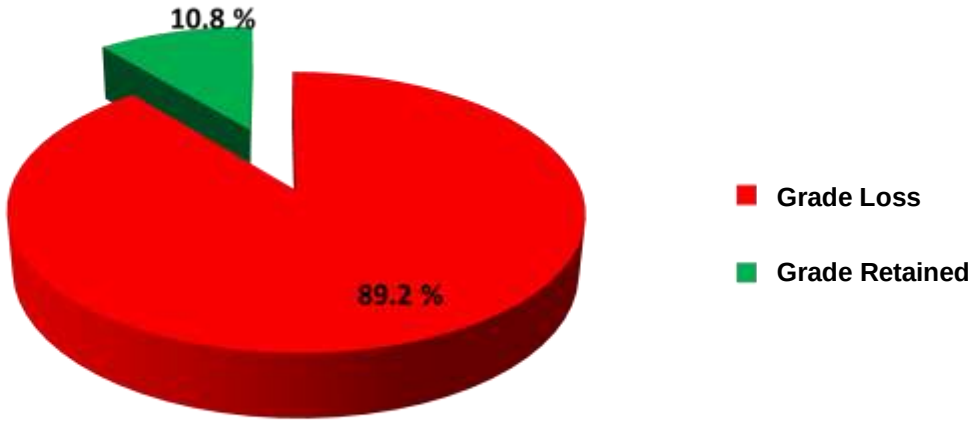

Figure 10. Grade losses during transportation (referring to grade loss, not outright loss).

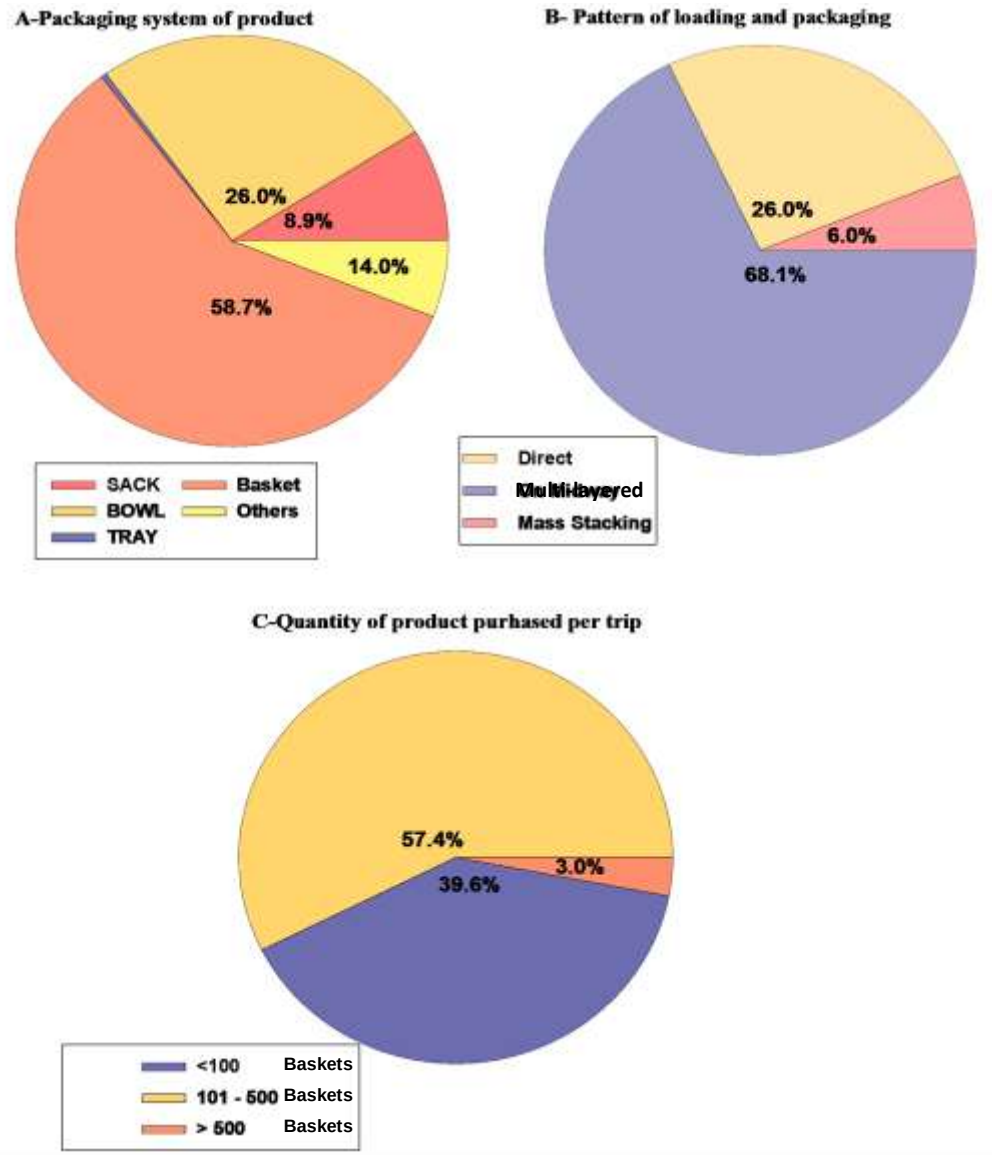

Figure 11. Status of handling and transportation of fresh commodities.

Table 2. Other loads were placed in the vehicle.

Scale	Frequency	Percent
Yes	97	41.3
No	138	58.7
Total	235	100.0

Table 3. The products are offloaded immediately after transportation.

Scale	Frequency	Percent
Yes	168	71.5
No	67	28.5
Total	235	100.0

insect damage could be as high as between 10 and 20% of products bought as shown in Figure 12c.

Method of storage and description of storage structures

As shown in Table 4, it was observed that 56.1% of the traders store their products directly on the floor of their market stalls, stores and warehouses. This allows insects, rodents and other vectors to easily damage the crops before sales. Furthermore, 36.2% of the traders store their crops in containers that are not well-ventilated, and some of the crops are lost due to heat build-up within the containers. Even though 51.1% of the traders reported that they store their products in well-ventilated

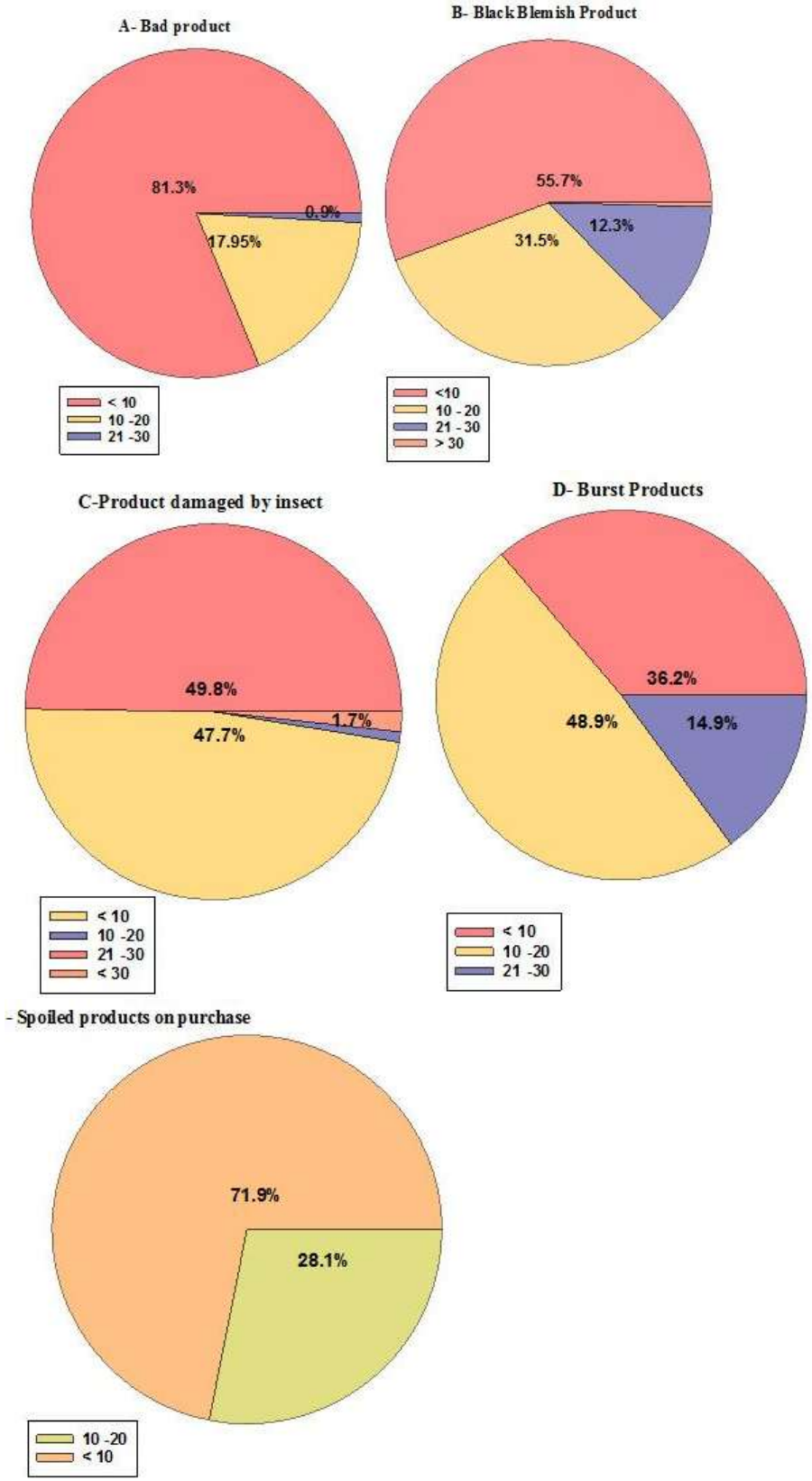

Figure 12. Percentage of damages and losses of fruit and vegetable during the purchase.

Table 4. Method of storage and description of storage structures.

Scale	Frequency	Percent
Products are stored piled on the floor		
No	103	43.8
Yes	132	56.1
Total	235	100
Products are stored piled on a wooden platform		
No	134	57
Yes	101	43
Total	235	100
Products are stored in containers		
No	150	63.8
Yes	85	36.2
Total	235	100
Where are the products stored?		
Storage type		
Enclosed room	37	15.7
Ventilated room	120	51.1
Outdoor	78	33.2
Total	235	100
Challenges faced		
Water/rain	49	20.9
Heat/sun	120	51.1
Others	66	28.1
Total	235	100

Figure 13. Outdoor display and storage of banana and plantain at Oje market.

stores, careful observations from this study revealed that these structures do not meet the functional requirements for the storage of fruits and vegetables. About 33.2% of respondents also store their products outside, covered with tarps. Figures 13 to 16 show the various methods employed for the storage of fruits and vegetables in the markets. Respondents also indicated that most of the time, their products were heaped on the floor or in

Figure 14. Outdoor storage of oranges and tangerine at Oje market.

Figure 15. Storage of pepper and onion in a storeroom at Sasa market.

containers (baskets) inside stores with little ventilation. Produce closer to the floor was found to be more prone to insect attack and spoilage. At the current level of technology adopted at the market level, the traders and wholesalers typically keep tomatoes profitably for about 10 days depending on the level of ripeness while retailers keep ripe tomatoes for about 5 days. Therefore, when products such as tomatoes remain in store for over a week and rot sets in, as new batches of products are brought into the store, the spoilt produce endangers good ones which they come in contact with.

The methods of storage in the 5 markets encourage the breeding of insects, rodents, molds, and early spoilage of crops. Exposing some fruits and vegetables to direct radiation from the sun or rainfall can hasten deterioration. For instance, the traders reported that during the rainy season, due to defective market-level storage facilities, rainwater contributes to the rapid deterioration of some of their crops e.g., onions. About 51.1% of the traders also blamed the high temperatures retained in their stores as shown in Table 4.

CONCLUSION AND RECOMMENDATIONS

Storage of fruits and vegetables in enclosed rooms, with

Figure 16. Outdoor storage of onions on a wooden platform at Oje market.

little or no ventilation, was observed in all the markets surveyed and the negative effects on the stored produce are obvious because the crops require fresh air/ventilation to bring about cooling. For successful storage of fruits and vegetables, both transporters and marketers should be well-grounded in the basic guiding principles. This study confirms that postharvest loss of fruits and vegetables at the market level remains high. It was also observed that grade loss is largely induced by poor handling and loading systems, bad transportation, poor packing and packaging technologies, poor storage infrastructure, and ineffective management practices. Reducing postharvest losses of fruits and vegetables is a way of increasing food availability all year round. Based on observations, it is recommended that government at all levels should ensure that there is an improvement on roads and maintenance of transport infrastructure to reduce impact damage on crops being transported. The traders should also ensure that market-level storage structures are in proper conditions to safeguard the quality of stored products. All actors in the value chain also require adequate training to improve handling practices for fresh commodities.

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