

A Survey of Post-Harvest Techniques Employed in Handling and Storage of Sweet Oranges (*Citrus sinensis* Osberk) in Lagos, Ogun and Osun States, Nigeria

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ABSTRACT---- *Post-Harvest losses of fruits are considered to be a major problem that affects many farmers in most developing countries like Nigeria. Reduction of post-harvest losses and quality deterioration are essential in increasing food availability from the existing productions. Minimizing this loss has great significance for food security, economic growth and welfare of the society. Losses are caused by a variety of factors ranging from growth conditions, pre-harvest practices, types of harvesting techniques, post-harvest practices, means of transportations, condition of roads and retail stores or market. This survey was conducted to explore the farmers' practices, gender, harvesting techniques, means of transportation, wholesalers and retailers and consumers information. Structured questionnaires on farm gate, transportation, marketing, consumers, and post-harvest practices were administered to randomly, selected sweet orange (*Citrus sinensis* Osberk) farmers, marketers and consumers from all local government areas in each three states (Lagos, Osun, Ogun States). The data collected were subjected to descriptive analysis, means, percentages and graphs were drawn. The survey revealed that poor infrastructure, lack of formal education and poor agricultural practices account for over 50% losses from farm to the markets and finally to the consumers. Most traders took fruits to markets for sale without considering the quality of the produce. More than 70% of the respondents clear their farm by bush clearing using hired labourers. Orange plucking using long poles and shaking were practiced by 90-100% of farmers in the 3 states. Farmers heap their fruits on bare floor in Truck/ Lorries, pick up van and saloon cars (taxis). Over 90% of respondents made gains or profits from sweet orange business. Results also revealed 100% of respondents consumed sweet orange raw/fresh. Wholesalers and retailers were not aware of any suitable storage structures either in the market or on farm. The designed Go-to-Hell used for harvesting oranges had no degree of diseases incidence compared to long stick or shaking. The agricultural practices employed in handling and storage of sweet oranges in Lagos, Ogun and Osun States need to be improved upon.*

Keywords--- Post-Harvest, Questionnaires, Harvesting Tools, Respondent, Sweet Oranges

1. INTRODUCTION

Three quarters of the world population live in rural areas and majority earn their living through agriculture. The Importance of agriculture on the economy and in the labour force is particularly marked in the lower income of developing countries of Asia and Africa. One part of the challenge involves raising the incomes of the poor in situ by raising agricultural productivity, enabling changes in production of structures, improving rural infrastructure and reducing their vulnerability through better functioning markets and stronger social safety network (Fukase and Martins 2015).

Most fruits and vegetables are seasonal and perishable in nature. In a good season there may be a local glut followed by famine during off season. Hence, several authors (Hall, 1968; Adeniji, 1977; Agboola, 1980; Adesida 2009 and Adekalu 2014) have pointed out the need to march all efforts to save crop that are produced from deterioration and waste. Citrus fruits have relatively long post-harvest life in comparison with other sub-tropical fruits. The type of handling before and after harvest, and the citrus variety and cultivar, may influence fruit quality in marketing (Murata, 1997). Citrus fruits are rich in vitamins especially vitamin C, its mild acidic and bitter taste makes digestion favourable and helps blood circulation. Citrus peels are rich in pectin, valuable in making jellies and jams. Citric acid manufactured from citrus fruits are used in acidification of carbonated beverages in bottling companies. Citrus fruits possess some medicinal properties; it's used in the treatment of many pathological diseases in humans such as scurvy, malformation of bone, teeth and connective tissue such as ligament and tendons. A healthy plant that is ten years old often bears 300-400 fruits.

Nigeria climate allows cultivation of fruits and vegetables. However, the postharvest loss is enormous due to absence of proper storage facilities, farmers are forced to sell their produce at throw away prices (Omolo *et al.*, 2011). This often leads

to economic losses occurring in the later part of food chain through excessive processing, packaging and marketing (FAO 2008). To this end, Booth and Coursey (1972) observed that increased food demand must be backed with focus on reduction of post-harvest losses that will lead to stabilization of prices during the season and off season.

Post-harvest losses vary greatly among commodities and countries. Conservation estimates suggest that out of more than 200 million tons of horticultural crops produced every year over 50% are lost between harvest and consumption (Adekalu 2014). Minimizing the post-harvest losses have been made through research on the physiological changes of the produce, storage structures, longer shelf-life varieties, suitable cultivation methods, optimum harvest indices, storage environment recommendations, pre-cooling, refrigeration, transportation methods, and improved handling methods. The critical handling point of any commercial fruit and vegetable operation is harvest; this is the starting point for the post-harvest management process. Following this is packaging, as it has been reported that poor packaging and rough handling during loading, unloading of trucks is responsible for the large incidence of mechanical damage of perishable produce in many developing countries (Ladapo, 2000). Optima care should be taken to ensure that fruits are not bruised or damaged in any form. Also, Heregods (1998) reported that suitable post-harvest research in developing countries should not be limited to storage conditions but also to market requirements, breeding and cultivating circumstances. Therefore, this survey was designed to assess the states of roads, transport facilities, type of packaging materials and/or containers, markets and consumers' information about sweet orange in three states of the country. The data generated from this research work may be useful to the government and/or any concerned body (NGO) in determining the kind of intervention needed in alleviating the problems in the covered areas.

2. MATERIALS AND METHODS

Exploratory survey was carried out in Lagos, Ogun and Osun states. This is for the purpose of identifying the oranges producing areas, method of harvesting, transportation, storage, sales of sweet orange and the personnel involved. The survey was representative of the citrus producing areas of the south-western Nigeria. Extension officers or field officers in each state, Agricultural Development Authorities were used to administer questionnaires in all the local government authorities in each state.



2.1 Part A: Farm gate (on-farm) information on sweet oranges in Lagos, Osun and Ogun States of Nigeria. In all the states 50 farmers were interviewed depending on each zone. Individuals who have independent control were also interviewed.

2.2 Part B: Transportation information on sweet oranges in Lagos, Osun and Ogun states. The survey was conducted using 50 transporters in Osun, Ogun and Lagos states with the help of questionnaires stressing the types of packaging containers used, for example, jute bag, fertilizer bags, bamboo basket and stacking of fruit in the vehicle without the use of containers. The duration of transportation from the southern part of the country was considered.

2.3 Part C: Market information on sweet oranges in the 3 States was also administered. Market survey from where citrus were obtained/ grown and where they were sold. Information on assembling point, wholesale/retail markets, a total number of 50 traders were interviewed.

2.4 Part D: Consumer Information on sweet oranges in the 3 States. 50 questionnaires were administered on availability of home storage units, user of the produce and its products frequency of purchase.

2.5 Part E: Postharvest information on sweet oranges was also structured to address the problem of post-harvest handling in the 3 states covered.

One hundred orange fruits were harvested for each trial of the harvesting methods: namely Harvesting tool, Local long stick, Hand plucking and Shaking of trees.

2.6 Analysis of data

Descriptive analysis such as frequency, percentages, mean, and graphs were drawn. Analysis of variance were done using SAS statistical package.



Plate 1: Designed and constructed tool; 'Go to Hell' for harvesting orange in the study area

3. RESULTS AND DISCUSSION

3.1 Farm gate information

The result of farm gate information recorded in the survey is as presented (Table 1). The result could be discussed under the following sub-divisions as shown in Table 1;

3.1.1 Gender

It showed that in all the states covered, male respondents were higher than female respondents. This envisages that more male respondents are seen at the farm gate than their female counterparts in the study area.

3.1.2 On-farm maintenance

All the respondents in each state embarked on bush clearing, weeding and pruning. They employ hired labourers to maintain their respective orchards. The labour forces used in the mode of harvesting were climbing, shaking and use of long pole.

Plate 2: (A) Produce transported in bulk in an open non-refrigerated truck; (B) Typical orange depot with the items spread on used bags; (C) An orange depot where distributions are made; (D) Mixture of bad oranges on display.



3.1.3 Profitability

All the respondents declared gain in the sweet oranges business. About 8.2% of respondents reported loss in Ogun state. Respondents harvest their sweet oranges in rural area and sold them to wholesalers in nearby markets. The major share of the profit in this case goes to the middle men.

3.1.4 Distribution point of harvested oranges

Most of the respondents (49.94%) take their harvest to collection centre for people to buy, while 34.69% of respondents take their oranges to wholesale markets and 12.24% of them transport the produce to the market for consumer to purchase directly.

Table 1: Distribution based on on-farm information of sweet oranges in the study area (n =100)

Variable	Lagos (%)	Ogun (%)	Osun (%)
Gender			
Male	22 (73.33)	41 (83.70)	18 (85.70)
Female	8 (26.67)	8 (16.30)	3 (14.30)
Orchard maintenance			
Clearing/pruning	30 (100)	30 (100)	30 (100)
Fertilizer	-	-	-
Profitability			
Yes	30 (100)	45 (91.80)	30 (100)
No	-	4 (8.20)	-

Values represent number respondents, parenthesis represents the percentage of respondents with positive response.

3.2 Harvesting methods

The responses to questions on methods of harvesting is as presented in Figure 1. The results showed that various methods of harvest in the three states include; manual harvest methods like shaking, using a long pole and climbing of tall orange trees. Manual harvest needs large labour force as it is very slow. By knowing the market and its needs, the grower can and must judge how important the requirements of appearance, maturity and flavour for the consumers are. The critical handling point of any commercial agricultural produce operation is harvest. A farmer must therefore, know the proper time and harvesting tool for his/her fruits.

Majority are still climbing to hand pluck, shaking and use of long poles. This is an indication that orchards/plantation/farm are underdeveloped (Kumar and Gamage 2011). Nigerian farmers are still practicing old traditional methods. This is in agreement with Ladapo (2000) report. Use of long pole, shaking of trees resulted in a lot of mechanical injury and hard labour.

This is the starting point of post-harvest management. Any mistake at the harvest would be reflected down the value chain (Adekalu2018). Rahman (2007) reported that harvesting system used and its management has a direct effect on the incidence and severity of mechanical injury. Warm and injured produce have a relatively short storage life and its susceptibility to diseases and infections as reported by Mohammed (2006). Harvesting determines the following: variability in maturity, physical composition, biological and microbial hazards (Adekalu 2014; Kader 1999). The level of adoption of recommended technologies are still inadequate to support the requirement of external markets. When fruits are difficult to harvest, like tall sweet orange trees/mangoes, it is of importance to prepare a cushion/foam material around the tree to prevent damage to fruit skin of Citrus /avocado. (Ladapo, 2000; Mrema, 2002).

3.3 Information on means of transportation of sweet oranges in the study area

3.3.1 Gender

The result showed that majority of respondents interviewed were male while 7% were female. This is an indication that means of transporting from one station to another is duty of male respondents. It is also an energy demanding, tedious and required a lot of experience in which female counterpart might find difficult.

3.3.2 Mode of operation

Respondent's mode of operation differs in each state. Majority transport sweet oranges from farm gate to farm-owners or wholesalers and get paid for their services, while few respondents buy and transport.

3.3.3 Membership of association

The relevance of association to the study comes from the fact that these different groups/ association are one of the several avenues of mobilizing people for collective's action. Over 80% belonged to association/group in the study area. High levels of social participation and linkages can give rise to high levels of idea/innovation denomination, mass adoption, knowledge advancement and increased productivity due to group dynamism.

3.3.4 Means of Transportation

Result revealed that respondents would either transport their harvest by lorry, pick up van, or saloon cars (taxi). Sources of oranges by either retailers or wholesalers through farm gate collection centres.

3.3.5 Methods of Transporting Sweet Oranges

Respondents transport their sweet oranges to other cities markets based on nearness. Oranges Transport vehicles are open Lorries. Large quantities of fruits retained on trucks/vans are cushioned/lined with grass /paddy straw, moss and banana leaves. Thereby expose the fruits to adverse weather conditions. Pick up vans, cabs, wheel barrows as transports vehicles. The physical damages suffered by the packaged fresh fruits (in raffia or bamboo or none) causes injuries this results in deep puncture, leading to water loss and rapid decay, impact caused by

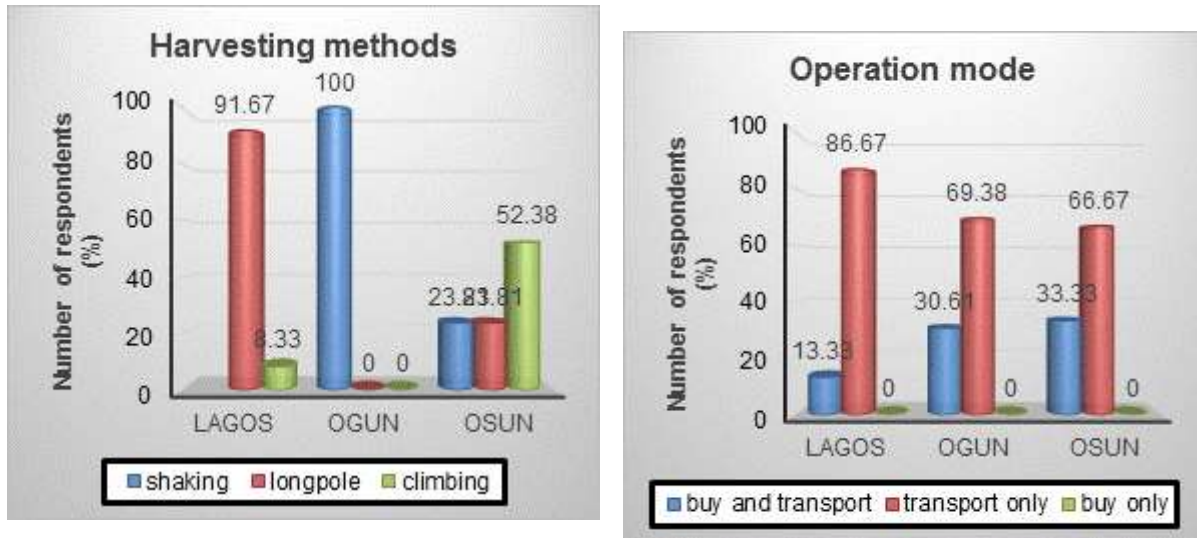


Figure 1: Harvesting methods and mode of operation of sweet oranges in Lagos, Ogun and Osun States.

Table 2: Distribution based on means of transportation of sweet oranges in the study areas (n =100)

Variable	Lagos %	Ogun %	Osun %
Gender			
Male	28 (93.33)	46 (93.88)	19 (90.48)
Female	2 (6.67)	3 (6.12)	2 (9.52)
Membership of association			
Yes	28 (93.33)	41 (83.76)	18 (85.71)
No	2 (6.67)	8 (16.24)	3 (14.29)

Value represents number of respondents while parenthesis represents percentages

Throwing also leads to bruising compression caused by overfilling as seen in Plate 1. Vibration of the vehicle due to rough or bad road as revealed in the survey. Heat damage caused by exposure of the fruits to direct sunlight and poor ventilation becoming overripe or soft or decay sets in. Moisture damages caused by exposing to rains, dew or high humidity this results in softening and collapse of the containers crushing the produce and decay. Suitable packages and handling techniques can reduce the amount of damage to which fresh produce is exposed during transportation and marketing.

The results depicted that over 50% of respondents in the area covered use pick up van to their destination while 40% use lorry and other cab. This was based on the nearness to big markets. No packaging material/container was used. Mixed loads of oranges, bananas and pineapples were observed and these are incompatible products with respect to temperature, relative humidity, different ethylene productions lead to fast deteriorations. This is in agreement with Morris (2018).

On the basis of their respiration rate and ethylene production patterns during maturation and ripening fruits can be classified into climacteric fruits (they exhibit a large increase in carbon dioxide and ethylene production coincident with their ripening). Non-climacteric fruits (which exhibit no changes in their low carbon dioxide and ethylene production rates during ripening) as reported by Paltrinieri (FAO Agricultural Services Bullentin 151).

In post-harvest physiology of most horticultural crops ethylene plays an important role, sometimes beneficial (improving quality of the produce by faster and more uniform ripening prior to retail distribution) and often deleterious (increasing the rate of senescence and reducing shelf life).

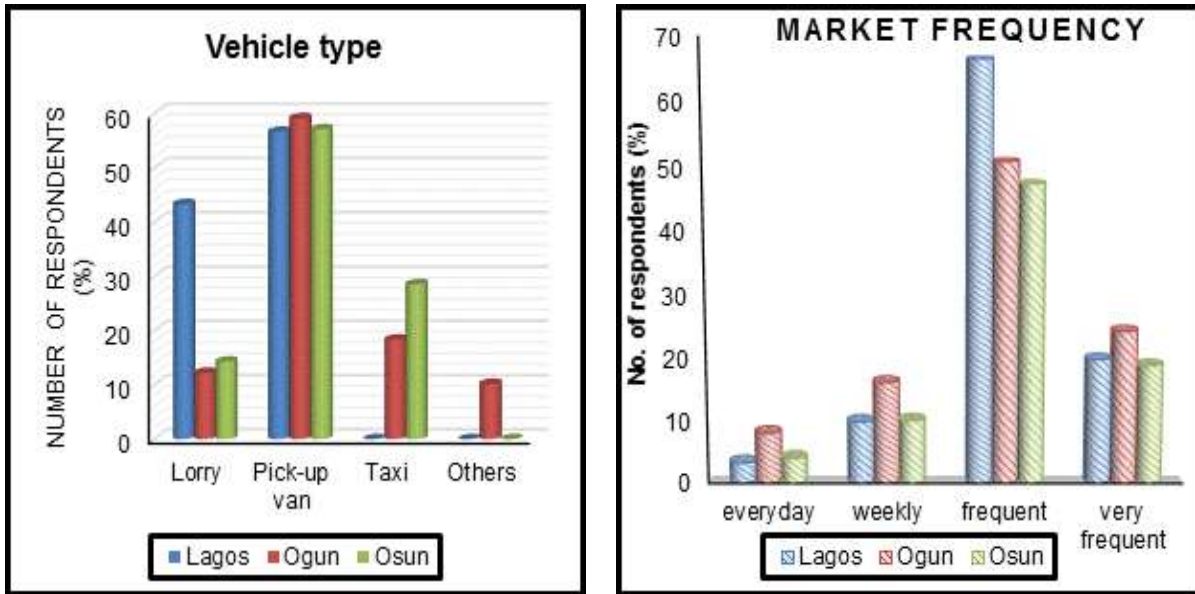


Figure 3: Type of vehicle used in transportation and Frequency of sweet orange market in Lagos, Ogun and Osun States.

Frequency of Market

The respondent's operations about sweet oranges trade was based on very frequent, frequent, weekly or everyday market. Over 50% of the respondents' frequent market on a daily basis during fruit season. Over 20% respondents very frequent and below 10% on a daily basis.

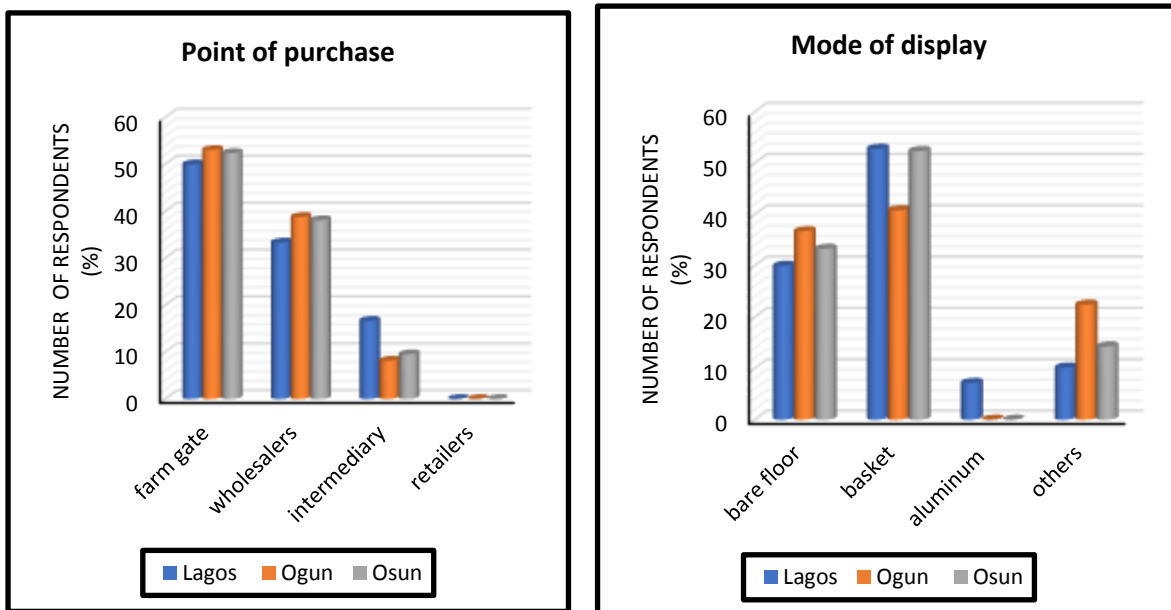


Figure 4: Point of buying and Method of display of sweet oranges in Lagos, Ogun and Osun States.

Point of purchase

The sale of sweet oranges can either be obtained from different means such as, farm gate, wholesaler, intermediaries and retailers. About 50% respondents buy their sweet oranges directly from farm gate while over 30% buy from the wholesaler and the others from intermediaries.

Mode of display

Results revealed that over 40% of the respondents display their products in raffia baskets as packaging containers. Other containers used in the study areas are plastic container, polyethylene bags, trays, bare floor or aluminum containers. The farmers are not changing with the fast-growing agricultural technology. Local raffia baskets, polyethylene sacs were used as packaging containers. These practices are archaic, it shows that the farmers in the study areas are not changing with trends in the world. New packaging containers such as collapsible wooden crates, plastic crates and refrigerated trucks

were not adopted (Nigerian stored products research institute 2010 bulletin). The new containers will reduce injury to fruits therefore leading to reduction in post-harvest losses and extension of storage life. Due to the bad harvesting, handling and transportation of produce, respondents do not store. Good packaging of fruits is essential if losses were to be minimized and quality maintained. These plastic crates are re-useable, returnable and stackable.

Market Information

Survey revealed that orange in Ogun and Osun states were less expensive compared to Lagos state. Excessive production during the peak season results in a slump on prices to unprecedented levels owing to markets gluts. Male and female wholesalers are more in Osun state than Lagos state. This can be attributed to bigger orange farms in Osun state.

Table 3: Distribution of customer based on market information in Lagos, Ogun and Osun State (n = 100)

Variable	Lagos %	Ogun %	Osun %
Gender			
Male	11 (36.67)	25 (51.02)	13 (61.91)
Female	19 (63.33)	24 (48.98)	8 (38.09)
Means of consuming oranges			
Raw	30 (100)	45 (91.84)	30 (100)
Processed		4 (08.16)	
Both	-	-	-
Do you buy orange			
Yes	22 (73.33)	40 (81.63)	18 (85.71)
No	8 (26.67)	9 (8.37)	3 (14.29)
Do you consume sweet orange all year round			
Yes	19 (63.33)	30 (61.22)	14 (66.67)
No	11 (33.67)	19 (38.78)	7 (33.33)

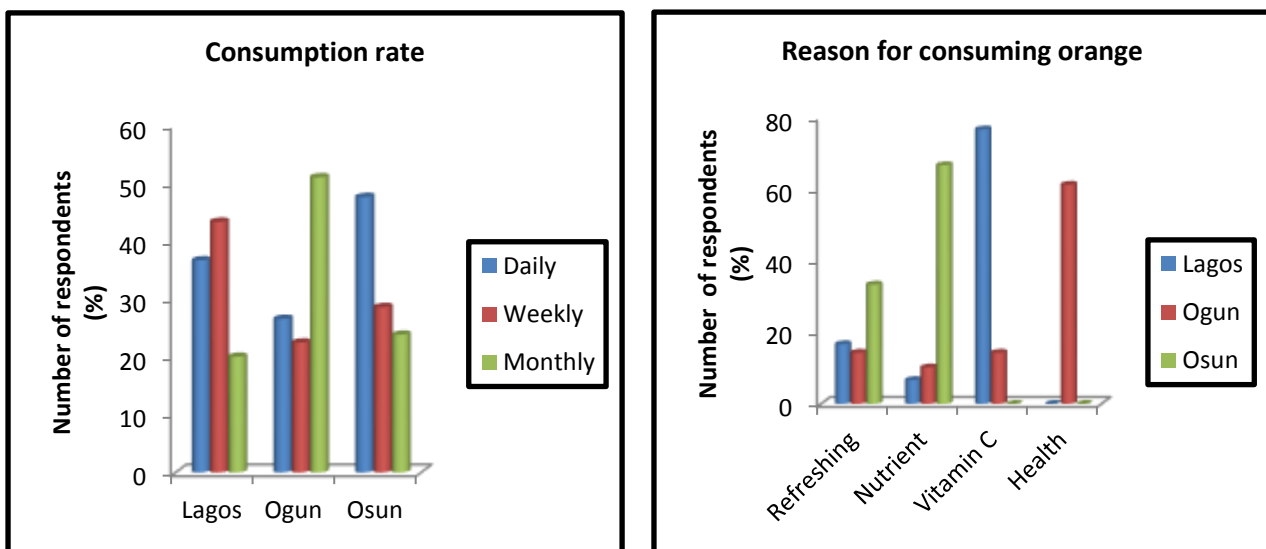


Figure 5: Consumption rate and reasons for consuming of sweet orange in Lagos, Ogun and Osun States

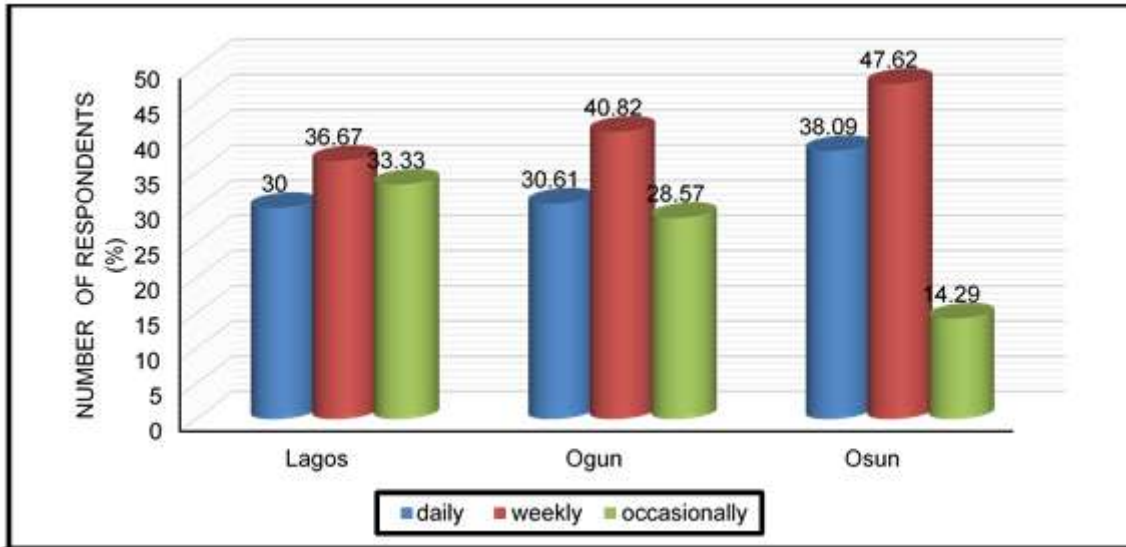


Figure 6: Consumer/Traders market information of Sweet Oranges in Lagos, Osun and Ogun States

3.4 Consumer/Traders market information of Sweet Oranges in Lagos, Osun and Ogun States

3.4.1 Gender:

Out of all the respondents interviewed for consumer marketing information on sweet oranges. Result showed that majority (86.67% Lagos, 85.72% Ogun and 85.71% Osun State) of the respondents were female involving in marketing of sweet oranges in the study area than their male counterpart. This is an indication that female is seen more in marketing of farm produce than male.

3.4.2 Frequency of market:

The result revealed that majority (83.33% in Lagos State, 57.14% in Ogun State and 66.67% in Osun State) of the respondents goes to the market on daily basis to sell their product (sweet orange) in the market, 10.00% of respondents in Lagos State, 24.49% of respondents in Ogun State and 23.81% of respondents in Osun State operate on weekly basis to sell their product (sweet orange) to the populace. While few 6.67% in Lagos State, 18.37% in Ogun State and 9.52% in Osun State operate on monthly basis to sell sweet orange in the study. It was observed that respondents in Ogun and Osun States go to market on five (5) days or daily to purchase sweet orange for sale.

3.4.3 Level of trading

Sweet orange can be marketed on the basis of wholesale, retailer or both wholesaler and retailer bases. Result showed that above half (56.67% of Lagos State, 55.10% of Ogun State and 52.38% of Osun State) of the respondents trade sweet orange on retailer, while 43.33 in Lagos State, 38.78% in Ogun State and 47.62% in Osun State of the respondents trade sweet oranges on wholesale. It was seen that only in Ogun State that few (6.12%) of the respondents' trade sweet orange as retailer and wholesaler. The survey showed that sweet orange marketers both wholesalers and retailers were not aware of any suitable storage structure both in the market or on-farm.

3.5 Discussion

A wide gap still exists between recommended technologies and their adoption rate. Retailers/Traders were not aware, talk less of affording cold storage facilities or plastic crates owing to high initial cost or capital and high operating cost of the facilities such as constant electricity supply.

Post-harvest information survey also revealed that most farmers or traders in the fruit business have little or no knowledge on harvesting quality and storage techniques. A much longer storage life is however required for a longer distance such as Osun state over 500 Km to Lagos State or Northern states. Proper packaging and pre-storage treatments losses would be minimizing and the country would have sufficient supply and prices would be stable. There is absolute lack of concept of packing house established in all the states covered, this is in agreement with Rolle (2005) in reports of the Asia-Pacific Regions. Also, Bogamoyo *et al.* (2013) reported that most traders in Tanzania took their fruits to markets for sale without considering the qualities of the produce. It was also observed that poor infrastructure from farm to market account for great losses in the market, including rough roads and means of traders. Both qualitative and qualitative data were gathered through questionnaires focus group discussions interview and observations. These reports are in agreement with Adekalu (2014).

Mohammed and Afework (2018) observed poor conditions of fruit handlers, problems related to transportation account for losses of horticultural produce in Ethiopia. Postharvest losses can be caused by a range of factors ranging from growing conditions, to handling at retail levels. Not only are losses clearly a waste of food but they represent a similar waste of human efforts, farm input, livelihood investment and scarce resources such as water. The exploratory survey has revealed and identified issues and constraints in reducing post-harvest losses and to define strategies and measures to reduce the losses. This is in agreement with Gudilla, et al. (2013).

Government should invest in post-harvest management, provision of packing houses or fruit shed for sorting cleaning, grading, cooling vans, cold rooms in packing houses. Entrepreneurs shall also be encouraged to own cooling vans, cold rooms and packing houses near their farms. This will contribute to employment creation, poverty and hunger reduction. Rural-urban migration would reduce, a number of important operations are also carried out in packing stations and different types of treatments are introduced after harvest. Due to lack of proper packing and packaging system in Nigeria and other developing countries large quantities/volume of the inedible portions of fruits and vegetables are transported to wholesale markets could be used as a value-added product and wastes. These inedible vegetable parts ultimately undergo decomposition, causes sanitation problems and produces gases which are detrimental to the environment.

There is need for primary processing as well, unlike durable crops such as cereals, pulses and oil seeds, fresh fruits and vegetables are highly perishable and must be marketed immediately after harvest. Fruits and vegetable generate large quantities of valuable waste that ends up as garbage. However, if they are gainfully utilized at the proper time, they can become value added products.

4. CONCLUSION

In the view of the findings it can concluded that post-harvest handling practices and knowledge of stakeholders involved in fruit sub sectors in the country are not good enough to prevent the losses. It is therefore imperative to improve educational knowledge skills on fruits quality on the field to reduce post-harvest losses in developing countries. Enactment and overhaul of Good Agricultural Practices (GAPs) laws is highly necessary in Nigeria. This would lead to reduction of post-harvest losses in Nigeria, more of wholesome food and reduction in illness, deaths and economical improvement. Cognizance of knowledge, skills and adoption of recommendations and technologies developed by Nigerian stored products research institute would lead to improvement in quality, safety and longer shelf life of produce. New Agric-business entrepreneurs/small-medium enterprises (SME) should be encouraged. Farmers should be provided with new short disease resistance varieties of sweet oranges for easy harvest. Building of fruits shed/ packing house should be encouraged. Use of foams under tall orange trees while shaking, would minimize physical or mechanical injuries. Use of stackable, nestable, re-useable plastic crates for packing and transporting. Establishment of juice processing factories should be ultimate priority.

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