Assessment of Orange (*Citrus Sinensis*) Supply Chain Activities in Kano State

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Abstract - The study focused on the handling system of orange in Yanlemo Market of Kano State. A field study was conducted with structural questionnaires that targeted the orange supplies, traders and agricultural equipment suppliers/fabricators. Result obtained reveals that the orange handling activity is dominated by male traders. Average of 2 to 5 bags of oranges are usually handled by about 53.3% of the respondents, while 8.3% handle more than 10 bags of the oranges daily. Dan Tivi was found to be the commonest orange variety in the study area. Some other varieties established in the study area are; Dan Nassarawa, Dan Ondo and Dan Delta representing about 8.3, 1.7 and 1.7% of the varieties handled in the study area respectively. The mode of transportation, sorting, and washing was found to be manual with a lot of challenges. The predominant manual handling of the orange established in the study area could be amongst the major reasons for the high losses usually recorded by the traders on a daily basis. Thus, useful suggestions that could be employed by researchers and policymakers to provide improvements in the supply chain activities to prevent such losses are presented.

Keywords - Orange, Assessment, Supply Chain, Handling

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1 INTRODUCTION

Fruits are the natural staple food of man containing substantial quantities of essential nutrients in adequate proportion. Fruits are excellent sources of minerals, vitamins, and enzymes that are easily digested and exercise cleansing effect on the blood and the digestive tract (Diana, 2018). Apart from being a very good source of food, fruits are also used as medicine; the ailments usually caused by the consumption of unnatural foods can easily be treated by fruits.

Sweet orange is one of the most important fruit crop grown all over the world. It belongs to citrus species which constitute the most important specie of the *Rutaceae* family. Fruits and vegetable storage in Nigeria is one of the most problematic handling operations. A lot of energy and food are lost between harvest and consumption. The oranges commodity in Kano state is mostly transported from the north-central and southern part of Nigeria which is a long distance journey of about 4 – 5 days (Idah 2007). As a result of which a lot of losses are incurred during the transit.

For instance, a study conducted in the Benue State of Nigeria revealed that 50% of orange is lost between the areas they are produced to where they are sold for consumption (Oyeniran, 1988). It is also reported that these losses usually occurred in transit and storage, and the losses were found more rapid under conditions of high temperature and humidity (Daramola, 1998 and Okhuoya, 1995). Furthermore, a preliminary study conducted in Kano establishes that the orange suppliers experience a lot of losses (25-40%) while handling before selling to the consumers. Therefore, this study aimed at studying the handling system of orange as practiced in the major marketing spot (Yan Lemo Market) in Kano State, Nigeria. It is hopeful that the study would provide useful information that can be used to identify the causes of these losses. Also, the information can be used by engineers in providing better handling methods and equipment that can curtail these losses and the anticipated drudgery in the current process.

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2 MATERIALS AND METHODS
2.1 MATERIALS
Structure questionnaire, weighing balance, stopwatch, and digital camera were the major materials used during data collection in the field.

2.2 QUESTIONNAIRE DESIGN AND ADMINISTRATION
Two sets of questionnaires were used for data collection. One questionnaire targeted the orange traders while the other targeted agricultural equipment suppliers and fabricators. The first questionnaire focused on - socio-economic information of the respondents, the quantity of orange-handled by the respondents, variety of orange-handled by the respondents, loading and unloading methods, transportation, sorting/grading, packaging, and washing methods used and also constraints and limitations in orange handling. The second questionnaire focused on - available orange loading and unloading, transportation, sorting/grading, packaging, and washing equipment.

2.3 METHODS
Sampling Technique and Sampling Size: Sixty (60) respondents were selected at random from the four (4) locations visited in the Study Area. Fifteen (15) questionnaires were administered in each location visited. Each respondent was separately interviewed and responses were filled on to the questionnaire. The responses of all the respondents were then gathered for further analysis.

Data Analysis: The data collected were analyzed using descriptive statistics including the percentage, arithmetic mean, and the frequency table.

3 RESULTS AND DISCUSSION
3.1 SOCIO-ECONOMIC INFORMATION
From the data collected (Table 1), it is revealed that 95% of the respondents were males while only 5% of the respondents were found to be females. This revealed that the activity is predominantly carried out by males' workers. This can be attributed to the religious and cultural background of the people in the study area. The study revealed that 46.7% of the respondents are

between 31-39 years of age, which shows that majority of the respondents are youths, indicating the rigour and high energy requirement of the process. 10%, 28.3%, and 15% were found to be 18-22 years, 23-30 years and more than 40 years respectively.

Table 1. Socio-economic Information of the Respondents

Parameter (s)	Frequency	Percentage (%)
Gender		
Male	57	95
Female	3	5
Total	60	100
Age (Years)		
18-22	6	10
23-30	17	28.3
31-39	28	46.7
>40	9	15
Total	60	100

3.2 VARIETIES OF ORANGE

It could be observed from the results that; different varieties of orange were available in the study area. The predominant orange variety in the study areas was Dan Benue (Dan Tivi) variety (88.3%) as shown in Table 2. The possible reasons for the Dan Benue variety dominating the market were due to its availability all year round and its resistance to damage due to the stacking of the bags (Fig. 1(a)). Another was resistance to harsh temperature during transportation from the producing area (Benue State). The other varieties available in the study area include Dan Nassarawa, Dan Ondo, and Dan Delta as shown by the percentage of handling (8.3%, 1.7%, and 1.7%, respectively).

Fig. 1: Manual Unloading Methods

3.3 TRANSPORTATION METHOD

From the result obtained, it was established that there were three (3) types of transport systems usually employed by the respondents depending On the destination distance and quantity of oranges handled. These are yan Dako (Fig. 2 (c)), wheelbarrow (Fig. 2 (d)), and motor vehicle (Fig. 2 (e) and 2 (f)). This slightly differs from the transport systems reported by Idah (2007). However, the used of a certain method depends on the transit distance and volume of fruits. The yan Dako method (Fig. 2 (a)) involved carrying the bags of oranges on the head or back of an individual to the intended destination, usually of 1-2 km distance. This method results in a lot of hardship and drudgery during the operation. This might result in deformation of some portion of the oranges in the bag, thus by extension is the loss to the handlers. The conveyance using wheelbarrow involved carrying the bag(s) of orange on

the wheelbarrow as shown in Fig.(2 (d)). This provides some sort of convenient way of transporting the bags of oranges with minimum damages. The disadvantage of this method is that only a few bags could be carried at a time within a short destination. The use of a motor vehicle to carry the bags of oranges provides a more convenient way of transporting this commodity to far destinations. Similar explanations were made in some literature (Jones *et al.*, 1991 and Sing and Sing 1992) in the handling of tomatoes in Kadawa, Kura local government Kano Muhammad *et al.*, (2014).

Fig. 2: Methods of Transporting Oranges

Based on the findings obtained (Table 2), it was established that two methods are usually employed for the loading and unloading of the oranges either packed in jute bags or free stuck inside the van or truck (Fig. 1). They are the manual method and semi-manual method, using a piece of wooden plank to load or unload the bags of orange from the vehicle by sliding the oranges bags on the surface of the inclined plank.

Table 2. Respondents Information on Oranges

Parameter (s)	Frequency	Percentage (%)
Orange Variety		
Dan Benue	53	88.3
Dan Nassarawa	5	8.3
Dan Ondo	1	1.7
Dan Delta	1	1.7
Total	60	100
Packaging Method (s)		
Conventional Basket	6	10
Catton Container	0	0
Jute Bag	5	8.3
Ordinary Sacks	49	81.7
Total	60	100
Loading/Unloading Method (s)		
Manual	57	95
Improved	3	5
Total	60	100

3.4 ORANGE SORTING/GRADING METHOD

It was obvious that the oranges handler in the study area usually performs two sorting and grading operations. First was to separate the damaged oranges from undamaged due to poor transport or due to over-ripening and second is done to grade the oranges based on sizes. Both the two methods were done manually as

observed in the study area. This is of concern due to the volume of oranges handled in the area. This may cause serious health problems due to the drudgery and poor posture while performing this operation. Lawan *et al.,* (2017) reported that the heartbeats of workers during sorting and grading of oranges was increased from 66.8 to 78 beats/min. This increased energy expenditure from 1.9012 to 3.6821 KJ/min.

3.5 ORANGE WASHING METHOD

More energy is expended during washing operation than sorting and grading (Lawan *et al.,* 2017). From the results obtained and observation made, it is established that the respondents usually used the manual method in washing their oranges which involve pouring the oranges in a container and wash it using water and detergent. The quantity of orange to be washed per head depends on the size and capacity of the container. The time taken also depends on the number of oranges in the container. The washing containers usually used were; steel bowl, wheelbarrow, plastic container and buckets of various sizes. The respondents complained about the inefficiency they usually experienced with this method. Fig. 3 depicted the method.

Fig. 3: Method of Washing Orange

3.6 ORANGE PACKAGING METHOD

Results reveal different methods used in packaging of oranges depending on the type of packaging material available. From the data collected, there are four different materials that were used for the packaging of oranges in the study area. Table 2 gave a summary of the packaging methods used. It was revealed most of the respondents (81.7%) are using ordinary sacks for packaging of the oranges. This indicated that there is no improved packaging of the oranges. Also, 8.3 and 10% of the respondents are using jute bags and conventional baskets. Similar packaging materials were reported by Idah (2007). This packaging material might not be efficient especially when it comes to transportation as highlighted, a lot of losses were reported. So, if plastic or wooden boxes with good aeration can be designed, they would definitely reduce damages to oranges during handling operation.

3.7 ORANGE STORAGE METHOD

Based on the data collected and observation made, it was established that all the respondents are using the platform storage method. The packaged oranges are usually kept in an open space with little attention to the pest and rodents or the scorching sun as shown in Fig. 4.

This practice is unhygienic and could lead to deterioration in quality. Despite the lack of electricity, convective cooling storages and sheds should design for such commodity so as to extend their shelf-life.

Fig.4: Platform Storage Method

3.8 DURATION OF ORANGE SUPPLY CHAIN ACTIVITIES

The result obtained from the respondents revealed that the minimum time spent by the respondents were; 5, 5, 10, 20, 10, and 20 minutes for loading, unloading, transporting (Yan Dako and Wheelbarrow method), sorting/grading, packaging and washing one bag of orange respectively. The detail of the time spent on various activities is given in Table 3.

Table 3. Duration of Orange Handling Activities

Activities	Time Spent (min)/Bag
Loading	5-10
Unloading	5-10
Transportation	10-15
Sorting/Grading	20-30
Packaging	10-15
Washing	20-30

3.9 PROBLEMS ASSOCIATED WITH THE SUPPLY CHAIN ACTIVITIES

The following problems were identified during the study;

i. The way and manner the manual loading and unloading used by the respondents could lead to injury and a lot of drudgery and inefficiency is involved in the activities, especially the loading, transportation, and washing of oranges.

ii. The manner in which the orange are packaged and transported in the vehicles could also lead to damage of orange.

iii. Toxicity of materials of the containers used in washing the oranges could result in deterioration of oranges and affect its value.

iv. The existing storage method exposed the orange to dust, air, sunlight, flies and harsh climatic conditions. Thus, depreciate the value of oranges and make them prone to deterioration.

3.10 AVAILABILITY OF ORANGE HANDLING EQUIPMENT

Agricultural Equipment Suppliers and Fabricators were surveyed. The organizations surveyed were; Sankara Nigeria Limited, IGIMS Machinery Suppliers, MDG Mechanical Works, John-Alao Technology, Dandago Agricultural Machineries, and Metal focus. Results obtained revealed that there was no improved handling

equipment available in the market either for orange or fruits at large. Only traditional and some improvised materials were available.

4 CONCLUSION

Based on the data obtained and the observations made during the study, it was established that orange handling operation is extensively carried out manually with attendant drudgery. Most of the devices/equipment used were improvised for handling oranges or other fruits which could lead to mechanical damages of the fruits. These resulted in a lot of problems that possibly lead to the depreciation and subsequent deterioration of the oranges, which causes huge losses usually experienced by the traders. Thus, the following recommendations are raised;

 i. Capacity building of the orange traders on Proper handling of orange.
 ii. Engineers should develop suitable handling/storage equipment that can be adaptable to the orange traders. Since the use of refrigerators is exorbitant and out of reach to the orange traders.

REFERENCES

Badayi, M.S. & Said S. (2012). Structure of Kano Economy. Paper published on www.kanoonline.com.

Daramola, A.M.(1998). Post-harvest handling of indigenous fruits and vegetables: Status, problems and prospects. Paper presented at the Meeting of Experts on Indigenous Crops and Animal Research and Development in Nigeria.

Diana H.(2018). 13 Health Benefit of Oranges.*http://www.care2.com/greenliving/13-health-benefits-of-oranges.html#ixzz3LgjG4rIb*

Idah, P.A., Ajisegiri, E.S.A., and Yisa, M.G. (2007). Fruits and vegetables handling and transportation in Nigeria. *AU Journal of Technology* 10(3): 175 – 183.

Lawan, I., Yahaya, K., Ahmad, Rabi K., Muhammad, A.I. (2017). Ergonomic evaluation of subjects involved in orange (Citrus Sinensis) handling operations in yanlemo market Kano state. Bayero *Journal of Pure and Applied Sciences* 10(2): 1- 6.

Muhammad, A.I., Attanda, M.L., Isiaka, M., Lawan, I., and Malami, A.M. (2014). Study on handling system for fresh tomato product in Kadawa irrigation project, Kano State. Proceedings of the International Conference of the Nigerian Institution of Agricultural Engineers held at the Federal University of Technology, Akure, Nigeria, 22nd - 26th, September 2014.

National Population Commission Report (2006). https://www.jstor.org/stable/25434601.

Okhuoya, J.A. (1995): *Controlling post-harvest losses in tomatoes and pepper. J. Trop. Postharv. 2: 136-42.*

Oyeniran, J.O. (1988). *Report of the nationally coordinated research project on fruits and vegetables in Nigeria. Proc.Nat. Workshop on Improved Packaging and Storage Systems for Fruits and Vegetables in Nigeria. Ilorin, Nigeria.*

Jones, C.S.; Holt, J.E.; and school, D. (1991). *A model to Predict damage to horticultural produce during transport. J. Agric. Engin. Res. 50.259.72*

Singh, A. & Singh, Y. (1992). *Effect of vibration during transportation on the quality of vegetables.* J. Agric. Mech. Asia, Africa, and Latin America. AMA 23: 70-72.