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IMPACT OF COVID – 19 PANDEMIC ON POSTHARVEST LOSSES IN FRESH PINEAPPLE (*Ananas comosus* (L.) Merrill) IN ILORIN, NIGERIA

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Abstract

As a result of the lockdown during COVID-19 pandemic, farmers and marketers in Ilorin metropolis incurred postharvest losses of fruits, the impact were examined in this study. The objective was to identify the types of postharvest losses, possible causes and storage method on pineapple fruits, in order to increase the shelf life and healthy city. 50 greengrocer respondents were selected. Data were collected with structured questionnaires; frequency and percentage analysis were used, while significant level ($p \leq 0.05$) was determined by tabulated Chi-square. Study revealed 3 types of losses at different stages of delivery. Farm gate losses were: mechanical losses (56%), physiological losses (20%) and pathological losses (24%); collection centre: mechanical losses (50%), physiological losses (16%) and pathological losses (34%); market centre: mechanical losses (34%), physiological losses (16%) and pathological losses (50%) and consumer's level: mechanical losses (30%), physiological losses (60%) and pathological losses (10%). Apart from the usual treatment of the fruits before pandemic, most remarkable result achieved on pathological losses and healthy city planning by agricultural, architectural and engineering research has been on the preventive control of the coronavirus. Research effort was undertaking during the lockdown and this led to the discovery of modular motorized fumigator that showed a good potential for preventive control, trial releases were carried out at Ilorin during the lockdown. Therefore, if these exertions would be supported, there may be better positivity on research and development prospects of Nigeria.

Keywords: Pineapple, Postharvest losses, Transportation, Coronavirus and Healthy city

Introduction

Coronavirus Pandemic has had a significant impact at three levels: the strengthening of the agricultural research capacity in the area of postharvest losses of fruits and vegetables management, improved productivity of architectural research mandate on healthy city planning and design for the people of the society and on engineering innovation, creativity, improvement and production of locally fabricated equipment for the prevention and flattened of the coronavirus pandemic curve in our society. Impact is generally expressed in terms of decrease levels on production and marketing values during the lockdown pandemic which translates into potential discouragement on the part of farmers and the marketers, where both the production and marketing levels were very low as a result of the lockdown announcement made by the Nigeria Centre for Disease Control (NCDC) to the general public as a safety measure against the spreading of the coronavirus diseases. Viral diseases are usually very difficult to treat. This is because the pathogen resides in the host's cells; and so, an attempt to kill it might result in the death of the cell. In essence, one may end up killing the host before the parasite! More emphasis is therefore placed on preventive measures which ensure that the pathogens do not find their way into the cells.

The Nigeria Centre for Disease Control was established in the year 2011 in response to the challenges of public health emergencies and to enhance Nigeria's preparedness and responses to epidemics through prevention, detection and control of communicable diseases. Coronavirus disease (COVID – 19) is caused by a new strain of coronavirus (SAR – CoV – 2) that has not been previously identified in humans. According the Director General of the Nigeria Centre for Disease Control Dr. Chikwe Ihekweazu, it was first reported to World Health Organization (WHO) on the 31st of December, 2019 in Wuhan, China (NCDC, 2020). The WHO Director General Tedros Adhanom Ghebreyesus said that although a vaccine will be an essential long – term tool for controlling COVID – 19, there are priorities that every country must focus on how to save lives now. These include empowering communities to understand that they are not helpless and that there are things everyone should do to protect themselves and others. That includes physical distancing, hand hygiene, covering coughs; staying home if you feel sick, wearing masks when appropriate and only sharing information from reliable sources (WHO, 2020).

Literature Review

Fruits and vegetables are in great demand as they form part of the diet of millions of people in the world (Idah *et al*., 2007). Losses as high as 50% are common in fruits and vegetables and these losses occur due to Biological, Chemical, Physiological as well as Mechanical factors (Kader, 1992). Other reasons according to Fallik and Ahorani (2004) are related to inadequate harvesting, handling and transportation. Pineapple is fast becoming a staple food product in the daily diet of many people and large consumption of pineapple is also attributed to other types of food and beverages industries that require the flavor of pineapple fruits. The pineapple (*Ananas comosus* (L) Merrill, family Bromeliaceae) was domesticated in tropical America, with south-eastern Brazil, Paraguay and northern Argentina being thought to be the place of origin (Laison-Cabot, 1992). Ananas (2N = 50) and its closely related genus Pseudoananas (2N = 100) are distinguished among Ananas species could be due to ecological isolation rather than genetic divergences (Laison-Cabot, 1992; Aradhya *et al*., 1994). Of the many pineapple varieties, 'Smooth Cayenne' is the major commercial variety. Other varieties are grown on a small scale (Grazia *et al*., 1980), with many lines selected for specific localities with only limited breeding work (Cabot, 1987). Though 'Smooth Cayenne' is the major variety worldwide, it has deficiencies as a fresh fruit. These deficiencies include high acidity, low ascorbic acid, poor flavor and a susceptibility to translucency (Paull, 1992). In a preliminary survey of postharvest losses of some fruits and vegetables in western Nigeria it was found that losses occurred at different stages of the delivery system right from the farm gate to the urban markets (Olorunda and Aboaba, 1978).

The damages that occur are due to mechanical, physiological and pathological factors. Mechanical injury takes many forms such as bruising, cleavage, punctures and ruptures and may occur at any stage from before harvest to handling within the consumer's household. These forms of damages cause increased respiration, which leads to reduction of storage life and provides infections sites for microorganism. Physiological disorder takes many forms such as chilling injury, flesh translucency, bruising, sun-born, malformation and may occur during the postharvest and handling stage by the consumers. Fruit with increasing translucency have increased pH, total soluble solid, acid ratio and weight, lower total ester and acids. Total soluble solid, flesh pigments and palatability increase to a maximum at about 60% translucency (Bowden, 1996). Postharvest pathology such as pests and diseases of pineapple are universally distributed as vegetative germplasm has been transported around the world. The 'Smooth Cayenne cultivar is relatively resistant to most pineapple diseases (Rohrbach and Phillips, 1990).

A healthy city is one that is continually creating and improving those physical and social environments and expanding those community resources which enable people to mutually support each other in performing all the functions of life and developing to their maximum potential (WHO, 1995). Healthy cities as a concept is a public health approach built on the premises that improvements in health among the population of the developed countries in the 19th and 20th centuries were not as a result of advances in medicine, medical care and technology, but consequent on social, environmental and economic changes. Such changes include limitations to family size, increase in food and shelter supplies, reduced poverty, and a healthier physical environment devoid of physical crowding, poor waste disposal systems; unsafe working conditions and environmental pollution; as well as promotion of specific preventive and therapeutic behaviours (WHO, 2000)

Specifically, the healthy cities programme sees health as being dependent not only on good Medicare services and infrastructure or the lifestyles of individuals alone, but also on supportive physical, economic and social environments. These physical, social and economic environments are described as health setting (WHO, 1995). These setting are therefore the contexts within which people engage in daily activities where- in environmental, organizational and personal factors interact to affect health. Setting can normally be identified as having physical boundaries, a range of people with defined roles, and an organizational structure such as school, work places, hospitals, villages, town and cities. It is essentially a facilitating programme aimed at promotion and institutional development at both the municipal and local level which is very crucial at this lockdown period of coronavirus pandemic.

As many countries begin to lift lockdown measures, focus on the fight against COVID – 19 has developed into examining what measures can be taken to prevent a second wave of infections. Among the potential solutions are engineering and technological efforts, such as contact tracing and increased research and development of personal protective equipment of the type modular motorized fumigator invented by the Oodua Machine and Tools under the leadership of His Imperial Majesty, Oonirisa of Ife, Oba Adeyeye Enitan Ogunwusi, Ojaja II. The machine was locally fabricated and very effective for the preventive control of coronavirus diseases, in His kind gesture one of the equipment was donated to Kwara State University, Malete. It was used for this research work during the lockdown

and showed a positive impact; hence, provision of new technical information in itself enables both the farmers and marketers to improve their productivity, marketing, health and other aspects of their lives.

Research Objectives

Therefore, the objective was to identify the types of postharvest losses, possible causes and storage method on pineapple fruits, in order to increase the shelf life and healthy city.

Methodology

Ilorin is the capital of Kwara State, one of the 36 states in the country and located in the north central region. Ilorin has a growing population of over 1 million spread across three local governments and located on latitude 8^{o} 24' north of the equator and longitude 4^{o} 10' west of the Greenwich Meridian. The city has a tropical savanna climate with dry winter. Thus, it is covered by grassland and forests and experiences a fairly high temperature, moderate rainfall and relative humidity of between 75 to 80% during the wet season, while in the dry season, it is about 65%. An investigative survey research approach method was used in Ilorin city to obtain information on harvesting methods used by the farmers, sources of labours, collection centres or assembly points for pineapple and the production constraints among other things (Idah *et al*., 2007). A separate questionnaire was used for the market survey, which represent the markets from where pineapples were bought and sold respectively. It was meant to obtain information on the assembly points, the wholesale and retail markets. The transportation survey was also conducted, with the help of a questionnaire stressing the types of packaging containers such as jute bags, weaving baskets, vegetable basket and stacking the fruits in the vehicle without the use of containers, duration of transportation was also considered. A consumer questionnaire was used in Ilorin on the availability of home storage units and users of pineapples and their products and the frequencies of purchase. 50 greengrocer respondents were selected. Data were collected with structured questionnaires; frequency and percentage analysis were used, while significant level ($p \leq 0.05$) was determined by tabulated Chi-square (X^2). Motorized modular fumigator was used as a preventive control measure against coronavirus pandemic.

Figure 1: Handing Over of Motorized Modular Fumigator at the Oonirisa Palace, Ife.

Results

Farm Gate Information

Chi-square is a non-parametric statistics, it is used when frequency are used, therefore, results of the field survey were presented in the four tables below with the tabulated Chi-square at significant level ($p \leq 0.05$) at different stages of the information assessed. The percentage of the men who engaged in the production of pineapple according to Table 1 was 40% while only 60% were women. 50% of the losses at farm gate were as a result of lack of storage system and lockdown period.

Table 1: Farm Gate Information on Various Characteristics Assessed

Variable	No of Respondents	Percentage
Gender of farmer		
Male	20	40
Female	30	60
Significant@X^2 ($p \leq 0.05$)	3.841	
Harvesting techniques		

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Hand-harvesting	48		96
Chemical	1		2
Chemical/harvesting	1		2
Significant@X^2 ($p \leq 0.05$)		5.991	
Causes of postharvest losses			
Rough handling	12		24
Packaging	8		16
Storage system	30		60
Significant@X^2 ($p \leq 0.05$)		5.991	
Storage method			
Fruit shed	28		56
Vegetable Baskets	15		30
Refrigerator	7		14
Significant@X^2 ($p \leq 0.05$)		5.991	
Produce convey method			
Truck	8		16
Pick-up	30		60
Picker	12		24
Significant@X^2 ($p \leq 0.05$)		5.991	
Classification of losses			
Mechanical losses	28		56
Physiological losses	10		20
Pathological losses	12		24
Significant@X^2 ($p \leq 0.05$)		5.991	

Collection Centre Information

At the collection centre, according to Table 2 the losses were as a result of pests and diseases caused by insects infestation and lack of good storage system, most of the centre could not be reached easily due to the lockdown pandemic and this resulted into damages and losses of the fruits, those losses are classified into: 50% mechanical losses, 16% physiological losses and 34% pathological losses.

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Table 2: Collection Centre Information on Various Characteristics Assessed

Variable	No of Respondents	Percentage
Gender of farmer		
Male	20	40
Female	30	60
Significant@X^2 ($p \leq 0.05$)	3.841	
Collection centre		
Farm gate	12	24
Assembly point	30	60
Wholesale market	8	16
Significant@X^2 ($p \leq 0.05$)	5.991	
Method of collection		
Hand picker	48	96
Conveyor	1	2
Field bin	1	2
Significant@X^2 ($p \leq 0.05$)	5.991	
Storage method		
Fruit shed	30	60
Vegetable basket	12	24
Refrigerator	8	16
Significant@X^2 ($p \leq 0.05$)	5.991	
Treatment of fruit		
Yes	8	16
No	40	80
partially	2	4
Significant@X^2 ($p \leq 0.05$)	5.991	
Classification of losses		
Mechanical losses	25	50

Physiological losses	8		16
Pathological losses	17		34
Significant@X^2 ($p \leq 0.05$)		5.991	

Market Centre Information

At the market centre, according to Table 3 the losses were as a result of pests and diseases caused by insects infestation and lack of good storage system, most of the centre could not be reached easily, as there was no means of transportation due to the lockdown pandemic and this resulted into damages and losses of the fruits, those losses are classified into: 50% mechanical losses, 16% physiological losses and 34% pathological losses.

Table 3: Market Centre Information on Various Characteristics Assessed

Variable	No of Respondents		Percentage
Gender of farmer			
Male	20		40
Female	30		60
Significant@X^2 ($p \leq 0.05$)		3.841	
Collection centre			
Farm gate	12		24
Assembly point	30		60
Wholesale market	8		16
Significant@X^2 ($p \leq 0.05$)		5.991	
Method of collection			
Hand picker	48		96
Conveyor	1		2
Field bin	1		
Significant@X^2 ($p \leq 0.05$)		5.991	
Storage method			
Fruit shed	30		60
Vegetable basket	12		24
Refrigerator	8		16
Significant@X^2 ($p \leq 0.05$)		5.991	

Treatment of fruit			
Yes	8		16
No	41		82
Partially	1		2
Significant@X^2 ($p \leq 0.05$)		5.991	
Classification of losses			
Mechanical losses	25		50
Physiological losses	8		16
Pathological losses	17		34
Significant@X^2 ($p \leq 0.05$)		5.991	

Consumer Centre Information

According to Table 4, the survey revealed that about 84% of consumers bought their pineapple fruits fresh from the market and not from the farm gate. About 40% of the consumers stored the fruits in the refrigerator. Only about 30% of the mechanical losses were recorded while physiological losses of about 60% was recorded as the highest losses during the lockdown period as a result of coronavirus diseases.

Table 4: Consumer Centre Information on Various Characteristics Assessed

Variable	No of Respondents		Percentage
Gender of the consumer			
Male	20		40
Female	30		60
Significant@X^2 ($p \leq 0.05$)		3.841	
Nature of Pineapple bought			
Fresh	40		80
Not fresh	8		16
In-between	2		4
Significant@X^2 ($p \leq 0.05$)		5.991	
Treatment of fruits			
Washing	38		76
Processing	10		20

Chemical	2		4
Significant@X^2 ($p \leq 0.05$)		5.991	
Storage method			
Ventilated kitchen plate	25		50
Refrigerator	20		40
Open-shed	5		10
Significant@X^2 ($p \leq 0.05$)		5.991	
Sorting of fruits			
Yes	10		20
No	39		78
Not really	1		2
Significant@X^2 ($p \leq 0.05$)		5.991	
Classification of losses			
Mechanical losses	15		30
Physiological losses	30		60
Pathological losses	5		10
Significant@X^2 ($p \leq 0.05$)		5.991	

Discussion

The exploratory survey indicated that majority of the farmers harvested their fruits by hands using sharp implements. As a result of this, mechanical injury, cuts, bruises, ruptures and punctures occur as holes which act as focal points for entry by microorganisms thereby causing pathological damages. This may also be accompanied by physiological damages due to wilting and moisture loss. The storage method used by the consumer were usually a form of packing the fruits in a ventilated kitchen plate as a form of open-shed storage where fruits were kept on shelves or on the floor to allow for adequate ventilation in their stores this is a common practice by consumers for the storage of pineapple fruits. The motorized modular fumigator was also confirmed to be quite effective by some of the respondents as a good preventive measure against coronavirus diseases.

The temperature and relative humidity in the postharvest environment not only affect moisture loss from stored fruits but also affects the activities of the decay causing agents. Wadia (1986) working on the effect of temperature and relative humidity on the postharvest disease of some tropical fruits and vegetables reported that these two factors have pronounced effects on pineapple diseases, this was also supported by Laszan *et al*. (1987) that higher temperature and relative humidity of 70 – 85% is desirable for proper management of postharvest diseases in pineapple fruits. The major factors contributing to postharvest deterioration are physical or mechanical damage, physiological damage and pathological damage due to degeneration by pests and diseases.

The storage duration and storage structures such as fruit-shed, vegetable basket and refrigerator at different temperature were found to have significant effects on some of the physical properties for example weight loss. Similarly they also had significant effect on some of the chemical properties namely: pH, total titratable acid, total

soluble solid and organoleptic changes. Considering the storage structures, the vegetable basket had lower weight loss due to the moderate temperature while the refrigerator had lowest weight losses due to lower temperature and relative humidity as compared to the vegetable basket. Temperatures with relative humidity have been reported as the most important environmental factors in the shelf life of fruits and vegetables (Wills *et al*., 1981). This also agreed with the finding of Babatola and Babalola (1997), which stated that high temperature would increase the rate of respiration as well as physiological processes and hasten ripening or decrease storage life of fruits as opposed to low temperature.

Postharvest losses or decay occurred throughout all stages of the delivery system to the marketing stage of the fruits, as result of the lockdown pandemic caused by the coronavirus. Possible intervention measure was proposed by the Nigeria Centre for Disease Control (NCDC) in accordance to the World Health Organization (WHO) guidelines in order to flatten the coronavirus curves, such measures are: physical distancing, hand hygiene, covering coughs; staying home if you feel sick, wearing masks when appropriate and only sharing information from reliable sources. This was also support by the used of the motorized modular fumigator as part of the research advancement during the COVID – 19 pandemic which most of the respondents confirmed to be effective preventive control measure against the spreading of the coronavirus diseases (Figure 1).

The temperature and relative humidity played a key role in postharvest decay. The control relative humility in the postharvest environment is often as important as controls of temperature and these two factors are difficult to separate. Relative humidity affects moisture loss and high moisture content favour decay organism. Hence, the loss of fruit quality and rate of decay was dependent on the storage method used and the duration of storage. Decay was rated as a ratio of diseases (unmarketable) to marketable fruits during the storage days. To manage this decay as source of postharvest losses of pineapple fruits during this coronavirus lockdown pandemic, storage structure, harvesting method, motorize modular fumigator and healthy city planning and design had been found to be quite effective. Also according to the respondents, transportation was another major cause of the postharvest losses in most of the pineapple fruits; this was support by Jones *et al*. (1991) that several factors are responsible for these damages and losses in the fresh produce. One of these factors is vibration resulting from the transport vehicles as they traverse undulating and irregularities on the roads. Another factor according the respondents was attributed to the lockdown period as a result of coronavirus disease pandemic.

Conclusion

Horticultural crops are also soft-texture and bruised with natural shelf life of a few days to several months. This is why they have to be handled with care during harvesting, packaging, transportation and marketing to avoid damages. They are perishable crops hence losses occur as a result of various primary and secondary factors. the primary factors are: Biological factors such as rodents, bird and wild animals, microbiological factors such as fungi and bacteria, chemical factors such as loss of nutritional values, biochemical factors, mechanical, pathological and physiological factors causing bruising, decay and wilting as a result of inadequate storage methods and lockdown pandemic. Secondary factors include: inadequate handling skills, inadequate storage facilities, traditional processing and marketing systems, which need to be improved, lack of adequate knowledge for maintaining food in good condition during storage. The COVID-19 pandemic is asking us two fundamental questions: what sort of world or society do we want? And what sort of postharvest management do we want? The answer to the first question will determine the answer to the second. Now more than ever, we need a healthier world and healthy city planning. Now more than ever, we need a safer world and society. Now more than ever, we need a fairer world. And now more than ever, we need a stronger research development in postharvest management in order to increase the shelf life of our fresh fruits during and after the COVID-19 Pandemic.

Recommendations

Based on the findings of this study, the following recommendations are made to ensure a proper management of postharvest losses in pineapple fruits during the lockdown pandemic and post COVID-19 management of horticultural crops.

1. The locally fabricated motorized modular fumigator by the Oodua Machine and Tools during the lockdown pandemic as a preventive measure against the spreading of coronavirus under the leadership of His Imperial Majesty, Oonirisa of Ife, Oba Adeyeye Enitan Ogunwusi Ojaja II, was tested and confirmed in this research work to be very effective and therefore recommended as an advancement in our research and technological development towards healthy city planning and food security in our society.

2. Also, processing of pineapple fruits into juices and chips appeared to be the best strategy for postharvest management and the use of appropriate storage structure and harvesting method in order to minimize pathological, physiological and mechanical damages due to cuts, bruises and ruptures are highly recommended for increase in the fruit shelf-life.

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