Studies on Post Harvest Deterioration of Some Fruits and Vegetables in Selected Markets in Lagos State, Nigeria

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ABSTRACT

Post harvest deterioration of Pineapple (*Ananas comosus*), Irish potato (*Solanum tuberosum),* Pawpaw (*Carica papaya*) and Carrot (*Daucus carota*) from three selected markets in Lagos State, Nigeria was studied. Both healthy and diseased samples were collected from the selected markets. Seven fungal species *Aspergillus sp., Penicillium sp., Rhizopus sp., Fusarium sp., Nigrospora sp., Phytopthora* sp.,and *Hendersonula toruloidea*; were found associated with deteriorating *Ananas comusus. Aspergillus niger, Aspergillus flavus, Aspergillus fumigatus, Mucor* sp, *Rhizopus* sp. and *Curvularia* sp. were associated with Irish potato. *Rhizopus stolonifer, Aspergillus niger, Mucor* sp, *Aspergilllus flavus, Penicillium* sp., and *Fusarium accuminatum* were associated with deteriorating *Carica papaya*. *Mucor* sp., *Rhizopus* sp, *Aspergillus niger, Aspergillus flavus, Aspergillus fumigatus, Alternaria* sp., *Fusarium* sp., and *Rhizopus* sp. were associated with *Daucus carota*. All isolated fungi were pathogenic to the different fruits when pathogencity tests were carried out.

Keywords: *Ananas comosus, Carica papaya, Daucus carota, Solanum tuberosum,* Post harvest deterioration, Fungal species.

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Introduction

Fruits are known to have commercial and nutritional importance. They play a vital role in human nutrition by supplying some necessary nutritional substances such as vitamins and essential minerals in human daily diet that can help to keep a good and normal health. Fruits are widely consumed. One of the factors that imparts negatively on the economic value of fruits is that they have a short shelf-life. This is as a result of many factors, prominent among which is the activity of pathogens. It has been reported (Droby, 2006; Zhu, 2006) that about 20-25% of the harvested fruits are lost via the activities of pathogens during post harvest chain.

Fruits and vegetables are exposed to contamination by microbes through contact with soil, dust and water and by handling at harvest or during postharvest processing. This makes them to harbour a wide range of microorganisms including plant and human pathogens (Eni *et al*., 2010). Differences in microbial profiles of diverse fruits and vegetables result could be due to varying factors including resident microflora in the soil, application of non-resident microflora through animal manures, sewage or irrigation water, transportation and handling by individual retailers (Ofor *et al*., 2009).

After banana and citrus, Pineapple (*Ananas comosus,* family Bromeliaceae*)* is ranked the third most important tropical fruit in the world. Nigeria is sixth on the list of world pineapple producers with about 800,000 tones produced per annum. *Ananas comosus* is a rich source of Vitamin C as well as other vitamins and fibre. The fruit is also used as a

raw material in confectionery industries. It also has various medicinal values (Amao *et al*., 2011).

Irish Potato (*Solanum tuberosum*) is of the family Solanaceae. It is a staple crop in 130 countries worldwide, ranking fourth in production after rice, maize, and wheat (Calvo *et al*., 2010), Nigeria being the fourth biggest producer in Sub Sahara Africa (FAO, 2008). The tuber is the most important part of the Irish potato plant and it is an excellent source of carbohydrates, protein and vitamins (Ducreaux *et al.,* 2005). In Nigeria, *S. tuberosum* is responsible for more than half of the total carbohydrate requirements of the populace in areas where it is grown and consumed as a staple food (Omafuvbe and Enyioha, 2011).

Pawpaw (*Carica papaya*), family Caricaceae, is a major fruit crop cultivated all over the world (Waller, 1992). Papaya fruit has high nutritive and medicinal value. The enzyme, papain, obtained from *C. papaya* is used as meat tenderizer, in manufacturing of chewing gum, in cosmetics (for shampoos and face lifting operation), and pharmaceutical industries. (Snowdon, 1990; Sherma, 1999).

Carrot (*Daucus carota)* belongs to the family Apiaceae. It is a root vegetable usually orange in colour, though purple, red, white and a yellow variety exists. It has a crisp texture when fresh (Salmond, 1994). The most commonly eaten part of carrot is the tap root. The leaves are not ingested in most of the cultures because it is mildly toxic but it is edible (Lantz, 1977). *D. carota* is very rich in vitamin C as well as carotene (Favel, 1998). Despite all the benefits derived from carrots, a large percentage is lost annually to post harvest deterioration caused by pathogens (Mahale *et al.,* 2008*)*.

In Nigeria, a visit to most markets revealed that between 15% and 40% of fruit displayed for sale showed symptoms of microbial infection and were sold at lower prices and were usually preferred by low income earners (Baiyewu *et al*., 2007). Gupta and Pathak (1986) reported that *Aspergillus niger, Aspergillus flavus, Rhizopus nigra, Curvalaria lanata,*

Rhizopus oryzae, Fusarium eqiuseti and *Fusarium moniliforme* were responsible for post harvest losses of pawpaw in south western Nigeria. Oke and Banjoko (1991) have also reported *Penicillium digitatum* and *Fusarium oxysporium* on pawpaw. Different fungal species have been reported to be associated with the post harvested deterioration of these fruits and vegetables in different locations. This study was carried out to investigate and document the fungi responsible for the spoilage of some fruits and vegetables from three selected markets in Lagos State, Nigeria.

MATERIALS AND METHODS

Survey and Sample Collection

Three markets in Lagos State, Nigeria: Iyana-Iba, Okoko and Agboju markets were surveyed. Diseased and healthy Pineapple (two varieties - Queen and Cayene Lisa), Pawpaw, Irish potato and Carrot were collected. All infected fruits and vegetables were inspected for rotted areas and were stored in clean polyethylene bags. The healthy samples were also stored separately. All the samples were brought to the Department of Botany Laboratory in Lagos State University, Ojo for further analysis.

Isolation of associated fungi

The diseased samples were first surface sterilized by washing under running tap water to remove dirt such as sand. A flamed blade was used to cut partly diseased and partly healthy portion of the sample, the cut portions were then surface sterilized using 70% alcohol after which they were rinsed in successive changes of sterile distilled water. They were then inoculated on Potato Dextrose Agar (PDA). This was done for all the samples from the three markets, the plates were incubated at 28^0C±2. Fungal growth was observed daily. After five days of incubation, a small portion of mycelium from each fungal colony was transferred

aseptically unto fresh plates containing the medium used. The fungi were purified by repeated sub-culturing.

Identification of isolated organisms

Using sterile inoculating needle, minute portion of each organism was aseptically taken and teased at the center of a clean microscopic slides containing drop of lactophenol cotton-blue stain, covered with cover slips and observed under the microscope. Identification was made with reference to standard textbooks such as Domsch *et al*., (1980), Barnett and Hunter (1992).

Establishment of pathogenicity of the isolated organisms

This was done by using a cork borer (5mm diameter) into the healthy plant samples and introducing the fungal isolates. The holes were then covered with the portions of the samples earlier removed and sealed with vaseline to prevent contamination. Discs of sterilized PDA were similarly introduced into healthy fruit or vegetables in each case to serve as control.

RESULTS

Penicillium sp., *Aspergillus flavus, A. niger, Fusarium subglutinans, Nigrospora* sp., *Phytopthora* sp., *Hendersonula toruloidea,* and *Rhizopus* sp. were isolated from both varieties of pineapple (Queen and the Cayene varieties) imported from Benin Republic and Nigeria respectively. Tables 1-4 show the distribution as per the markets, the organisms isolated.

Seven (7) fungi were isolated from *Solanum tuberosum* and they were: *Aspergillus niger, A. flavus, A. fumigatus, Rhizopus* sp., *Mucor* sp., *Curvularia* sp, and a yet to be identified organism. From the pathogenicity test, all the fungal isolates caused rot on healthy

tubers. *Rhizopus stolonifer, Aspergillus flavus, A. niger, Mucor* sp., *Penicillium* sp. and *Fusarium accuminatum* were isolated from diseased pawpaw fruits. For the pathogenicity tests, when the isolated organisms were inoculated into healthy pawpaw fruits, all the organisms were found to initiate diseases symptoms as found on the diseased pawpaw fruits. From Carrot, *Mucor* sp., *Rhizopus* sp. and *Aspergillus niger* were isolated from samples collected from Iyana-iba market: *Mucor* sp., *Rhizopus* sp. and *Alternaria* sp. from Okoko market; *Rhizopus* sp, *Aspergillus flavus, A. fumigatus* and *Fusarium* sp. from Agboju market. The result of the pathogenicity test revealed that all the fungi originally isolated from diseased carrots induce similar disease symptoms when inoculated on healthy carrots.

TABLE 1: Distribution of isolated fungi from *Ananas comosus* in different markets

FUNGI	MARKET	CAYENE VARIETY	QUEEN VARIETY
Penicillium sp.	Agboju	+	+
	Iyana-Iba	_	_
	Mushin	_	+
	Okoko	+	_
	Iyana-ipaja	_	+
Aspergillus flavus	Agboju	+	+
	Iyana-Iba	+	_
	Mushin	+	+
	Okoko	+	_
	Iyana-ipaja	+	+

Rhizopus niger	Agboju	+	_
	Iyana-Iba	_	_
	Mushin	+	+
	Okoko	_	_
	Iyana-ipaja	+	+
Fusarium subglutinans	Agboju	+	_
	Iyana-Iba	+	_
	Mushin	+	+
	Okoko	_	_
	Iyana-ipaja	+	_
Nigrospora sp.	Agboju	_	+
	Iyana-Iba	_	_
	Mushin	+	_
	Okoko	+	_
	Iyana-ipaja	_	+
Phytopthora sp	Agboju	+	+
	Iyana-Iba	+	_
	Mushin	+	_
	Okoko	+	_
	Iyana-ipaja	+	+
Hendersonula toruloidea	Agboju	_	_
	Iyana-Iba	_	_
	Mushin	_	+
	Okoko	_	_
	Iyana-ipaja	+	_

Aspergillus	Agboju	+	+
niger	Iyana-Iba	+	_
	Mushin	_	+
	Okoko	_	_
	Iyana-ipaja	+	+

KEY: - Absent, + Present

Table 2: Distribution of isolated fungi from Irish potato in different markets

ORGANISMS	IYANA-IBA MKT	OKOKO MKT	AGBOJU MKT
Aspergillus niger	+	+	_
Aspergillus flavus	+	_	_
Aspergillus fumigatus	_	_	+
Rhizopus sp.	+	+	+
Mucor sp.	+	+	+
Curvularia sp.	_	_	+
Unidentified	**+**	**_**	**+**

KEY: - Absent, + Present

Table 3: Distribution of isolated fungi from *Daucus carota* in different markets

ORGANISMS	IYANA-IBA MKT	OKOKO MKT	AGBOJU MKT
Aspergillus niger	+	_	_
Aspergillus flavus	_	_	+
Aspergillus fumigatus	_	_	+
Rhizopus sp.	+	+	+
Mucor sp.	+	+	_
Alternaria sp.	_	+	_
Fusarium sp.	_	_	+

KEY: - Absent, + Present

Table 4: Distribution of isolated fungi from *Carica papaya* in different markets

ORGANISMS	IYANA-IBA MKT	OKOKO MKT	AGBOJU MKT
Aspergillus niger	_	+	+
Aspergillus flavus	_	_	+
Rhizopus stolonifer	+	+	_
Mucor sp.	+	_	+
Penicillium sp.	_	+	_
Fusarium accuminatum	+	_	_

KEY: - Absent, + Present

DISCUSSION

Fruits and vegetables are susceptible to pathogenic attack due to their low P^H, high moisture content and nutrient composition. These make them rot and unfit for consumption

due to the production of mycotoxins (Stinson *et al.*, 1981; Philips, 1984). Fungi have been documented to penetrate host tissue through natural openings such as lenticels, stomata and through the unbroken epidermis by means of appresorium or germ tube. For an organism to cause infection, it must have the ability to breakdown the natural defence mechanisms of the host.

In this investigation, *Aspergillus flavus, Phytopthora* sp. were isolated from the Queen and the Cayene varieties of *Ananas comosus* this is in agreement with the work of Akinmusire, (2011) who also isolated *Aspergillus flavus* and *Phytopthora* sp. from *Ananas comosus*. Pathogenicity tests showed that the pathogens isolated affected both species of *Ananas comosus* but information is still needed to compare the effect of the sugar and nutritive content of both varieties on the growth of the fungal pathogens. Upon repeated isolation from the different species of *Ananas comosus* at different times from the same markets, *Aspergillus flavus, Rhizopus* sp. *and Fusarium* sp. were majorly recorded to be consistent. Before isolation and during pathogenicity it was observed that the rate of disintegration of the Queen variety was faster than that of the Cayene variety. But due to insufficient data it cannot be clearly ascertained if the real cause of this rapid deterioration is due to external or internal factors around or within the pineapple fruits.

Solanum tuberosum tubers are of high economic significance and are considered as one of the world's most important food crops. Many fungal diseases have been affecting its production but the most challenging are the post-harvest diseases. Booth (1974), reported that this losses were as a result of physical, physiological or pathological factors or a combination of the three factors and in this research, the diseased Irish Potato tubers collected has mechanical injuries due to physical factors. In the works of Abiodun and Olamide (2007), *Rhizopus oryzae* was among the organisms implicated for causing rot in *S. tuberosum* tuber. In this study, *Aspergillus niger,* and *Rhizopus* sp. were isolated from *S.*

tuberosum. This observation is consistent with a previous work (Amadioha and Adisa, 1993) that reported these organisms among others that were responsible for tuber rot in Irish potato.

In this investigation, the fungi associated with the spoilage of *Cacica papaya* are as reported by Gupta and Pathak (1986). Some of the pawpaw fruits found in these markets have been perched by birds and destroyed by insects which reduced the quality of fruit and also creating openings for pathogen entry. During the course of this study, after 3-5days, total rotting of the fruit occurs and as spot develops, some became sunken which turns to brown or black and oozes out a foul odor and milky latex. One of the diseased pawpaw (from Iyana-Iba market) was characterized by water soaked spot which is caused by *Fusarium accuminatum* has also been reported by Pathak (1976) and Barkai-Golan (1981).

Pathogenicity test result revealed *Rhizopus* sp. and *Aspergillus niger* were the most virulent on *S. tuberosum* and *Ananas comosus* while *Mucor* sp. Was the most virulent on *Daucus carota* and *Carica papaya*. The occurrence of organisms at the different markets showed *Rhizopus* sp. and *Mucor* sp. have the highest frequency followed by *Aspergillus niger.*

Different organisms have been isolated from carrot diseases ranging from *Pythium* sp. (McElroy *et al*., 1971), *Thielaviopsis basicola* (Punja and Gaya, 1993), *Fusarium* sp. (Piling and Cox, 1999), *Alternaria* sp. (Saude and Hausbeck, 1997). The variations in the isolates obtained from different researchers may be connected to the fact that different varieties of carrots may be used as well as different experimental procedures (Mildenhil, 1975). Difference in the location of sample collection can also be accountable for this. The market value of fruits and vegetables are reduced as a result of pathogen infestation. Their presence in these food produce also constitute health risks.

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