Scientia Africana, Vol. 23 (No. 3), August, 2024. Pp 197-202
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THE EFFECTS OF ORGANIC WASTE ON THE POSTHARVEST FUNGAL ATTACK AND DISEASE SEVERITY ON *IRVINGIA GABONENSIS* KERNELS

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Received: 12-06-2024
Accepted: 11-07-2024

https://dx.doi.org/10.4314/sa.v23i3.19

Journal Homepage: http://www.scientia-african.uniportjournal.info
Publisher: *Faculty of Science, University of Port Harcourt.*

ABSTRACT

The effects of organic waste, orange peels and charcoal on the postharvest fungal attack and disease severity on Irvingia gabonensis kernels stored for six (6) months was investigated. Irvingia gabonensis kernels were treated with orange peels and charcoal and the fungal load and diversity were determined using standard microbiological techniques. The study revealed that the same fungal species which include Aspergillus fumigatus, Aspergillusniger, Aspergillus terreus and Mucorspp were encountered in both treatment and control. Furthermore, it was observed that disease severity in the treatment sample reduced by 50 % on the average. The kernels stored in bags without treatment was discoloured and lost its market value whereas 86-88% of kernels stored in bags with either dried orange peels or charcoal remained in good condition. It was observed that the fungal load which ranged 1 CFU/g - too many to count in the control was significantly higher than those stored in bottles with treatment (1-3CFU/g). In orange peel treated kernels Aspergillus fumigatus was the most occurring fungal isolate (3 CFU/g). Aspergillus fumigatus and Mucor spp. were the most occurring in charcoal treated kernels with 2 CFU/g. while Mucor spp. was the most occurring (25 CFU/g) in the control, closely followed by Aspergillus fumigatus (14 CFU/g). Orange peels and charcoal were effective in reducing fungal spoilage of kernels and would prove useful in reducing postharvest loss.

Keywords: Charcoal, disease severity, fungal load, orange peels, postharvest loss

INTRODUCTION

Thousands of tons of African bush mango seeds (*Irvingia gabonensis*) are traded each year, mostly within Africa. *Irvingia gabonensis* is cultivated for the commercial production of its kernelsin southern Nigeria and southern Cameroon. They are rich incarbohydrates, protein, lipids and minerals. The kernels are widely traded locally and internationally from the forest zone to the savanna zone and between countries in West and Central Africa. They are also exported to Europefor African migrants in that part of the world to consume. Cameroon is the major exporter of *Irvingia gabonensis* among the producing countries in West Africa. The combined export trade of the kernels of *Irvingia gabonensis* and *Irvingia wombolu* from Cameroon to United States is about $260, 0000 annually. The kernels are very common throughout the year in local markets in Nigeria. They originate from the local forest, but are also commonly imported from Cameroon and Equatorial Guinea (Iyayi*et al.*, 2010).

Irivigia gabonensis kernels are prone to post harvest deterioration. This becomes a major challenge in its storage, marketing and consumption. Postharvest spoilage of *Irivingia* kernels is caused majorly by species of fungi, whose activities results in change in colour, reduction of market value and production of aflatoxin with their attendant health risks such as cancer, diarrhoea etc.Etebu and Bawo (2013) have reported the contamination of *Irivingia* kernels stored for 28 days by eight species of fungi which include: *Aspergillus niger* (26.60%), *Rhizopus stolonifer* (21.28%), *Aspergillus flavus* (19.15%), *Penicillium* spp. (10.64%), *Mucor* spp.(8.51%), *Candida tropicalis* (5.32%), *Phytophthora* spp.(4.26%) and *Fusarium oxysporum* (4.26%). Adebayo-Tayo *et al.* (2006) have also shown that fungal contaminated *Irvingia* kernels are potentially harmful to those people who consume them. In particular, they observed that fungal contaminated kernels possess aflatoxin. Aflatoxins are produced primarily by the fungi *Aspergillus flavus* and *A. parasiticus* (Wu and Khlangwiset 2010), and these fungi have been shown to grow on *Irvingia* kernels sampled for sale in Nigerian markets (Iyayi*et al*., 2010). Consumption of high levels of aflatoxin in foodcould pose a health risk and lead to death in extreme conditions (Lewis *et al*., 2005; Strosnider *et al*., 2006). An estimated 5 billion people are at risk of developing chronic heart diseases and other illnesses through exposure to foods contaminated with aflatoxins in developing countries. Yet, only little effort has been made to research on effective means of effective storage of *Irivingia*kernels that will prevent pathogenic fungi from growing on them. Postharvest conditions during storage, transportation, and food processing, amongst others; have been implicated as predisposing factors that enables*A. flavus* and *A. parasiticus*to grow and produce aflatoxins in contaminated food (Wu and Khlangwiset, 2010). It is therefore, important to improve on existing traditional storage methods that involves *Irvingiagabonensis* since the use of chemicals pose a health risk to human.

MATERIALS AND METHOD

Sample Collection

One hundred and fifty kilograms (150kg) of *Irvingia gabonesis* kernels were bought from Swali Market, Yenagoa, Bayelsa State. Pathologically healthy kernels were then sorted, sun- dried and stored in sterile bottles with two treatments: orange peels and charcoal.

Orange Peels

One hundred kilograms (100kg) of clean and fresh orange peels were collected from fruit vendor. They were then sundried until they became crispy. The orange peels were then added to 50 Kg *Irvingia gabonesis* kernels inside air tight bags.

Charcoal

One hundred and fifty kilograms (150 kg) of charcoal were bought from Swali Market, Yenagoa, Bayelsa State and then sundried to reduce dampness. The dried charcoal was then added to air tight bags containing 50kg of *Irvingia gabonesis* kernels.

Storage of Treated Samples

Three (3) replicates were made for each treatment-orange peels and charcoal. Also, three replicates were made for control (air - tight bottles containing *Irvingia gabonesis* kernels without any form of treatment. They were then kept in a cool and dry place. The setups were placed for six months.

Determination of Fungalpopulation

Two kilogramme (2 Kg) of each treatment was transferred into a beaker and 100 ml of distilled water was added to it as per the method of Bhalerao and Chavan (2017). The beaker was then shaken vigorously to dislodge fungi attached to the kernels. 1ml of water was then collected from the beaker and then serially diluted to 10^4.

Isolation of Fungi

Media, Potatoes Dextrose Agar (PDA) was prepared following instruction and aseptic

Scientia Africana, Vol. 23 (No. 3), August, 2024. Pp 197-202
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techniques. Exactly 0.1ml of fungal contaminated water was then collected and inoculated in Petri dishes containing PDA. The media was impregnated with 50µg ml-1 each of streptomycin.

The plates were thereafter incubated at ambient room temperature (28±2ºC) for 3 days. At the end of 3 days colony forming units were counted and the fungal population was expressed as colony forming units per gram (CFU/g). Discrete colonies were thereafter repeatedly subcultured after every three days onto freshly prepared agar plates until pure cultures were obtained. Fungal colonies were thereafter transferred onto Sabouraud dextrose agar (Oxoid Ltd, Hampshire, UK) and incubated in a sporulating chamber under darkness for 3 days in accordance with the method described by Etebu (2012). Identification of fungal isolates is based on macroscopic and microscopic usingSalvamani and Nawawi (2014) as guide.

Determination of Severity of Fungal Attack.

Postharvest disease of *Irvingia* kernels was identified by the appearance of brownish to black colouration on the kernels. Percentage incidence of infected kernels was determined as:

$$\text{Percentage Incidence (PI)} = \frac{\text{Number of discoloured kernels}}{10} x\ 100$$

The severity of postharvest fungal infection of individual kernels was determined by the ratio of infected area and expressed as percentage. The mean score of 10 kernels from a bag for each of the treatments was considered to represent a replicate.

RESULTS AND DISCUSSION

Table 1 shows severity of fungal attack on kernels of *Irvingia* stored using various treatment methods. It was observed that kernels stored with orange peels or charcoal as treatment had less fungal attack than those without any form of treatment. Large proportion of kernels without any form of treatment all became discoloured.

Table 1: Severity of fungal attack on *Irvingia* kernels stored using different treatments.

TREATMENT	NDK	NGK	TOTAL
Orange A1	15	85	100
Orange A2	11	89	100
Orange A3	23	77	100
Charcoal A1	30	70	100
Charcoal A2	18	22	100
Charcoal A3	15	85	100
Control A1	52	48	100
Control A2	45	55	100
Control A3	60	40	100

Keys: NDK= Number of Diseased kernels, NGK = Number of good kernels

Table 2 shows morphological traits of fungal species isolated from *Irvingia gabonensis* kernels subjected to different treatments and stored at room temperature. The same species of fungi was isolated from kernels stored kernels subjected to different pretreatments.

Table 2: Morphological traits of fungal species isolated from *Irvingia* kernels.

TRT	Isolate	Media	Morph	Margin	Elevation	Form
Orange	A	PDA	Blue-green velvety	Entire	raised	circular
	B	PDA	woolly dark- brown	Entire	flat	irregular
	C	PDA	Velvety cinnamon-brown	Entire	raised	circular
	D	PDA	White cottony flur	Entire	raised	irregular
Charcoal	A	PDA	Blue-green velvety	Entire	raised	circular
	B	PDA	woolly dark- brown	Entire	flat	irregular
	C	PDA	Velvety cinnamon-brown	Entire	raised	circular
	D	PDA	White cottony flur	Entire	raised	irregular
Control	A	PDA	Blue-green velvety	Entire	raised	circular
	B	PDA	Woolly dark- brown	Entire	flat	irregular
	C	PDA	Velvety cinnamon-brown	Entire	raised	circular
	D	PDA	White cottony flur	Entire	raised	irregular

Table 3 show number of colony-forming unit and average diameter of colonyof the different fungal species isolated. Fungi species isolated were *Aspergillus fumigatus*, *Aspergillus niger*, *Aspergillus terreus and mucor*sp. *Aspergillus fumigatus* had the highest fungal population (3 CFU/g) on kernels stored in orange peels, followed by *Mucor* sp. (2 CFU/g). The number of colony-forming unit on the control plates were significantly higher than those stored in treatments. *Mucor* sp.had the highest population in the control (25 CFU/g), followed by *Aspergillus fumigatus* which has 14 CFU/g.

Table 3: Number of colony-forming unit and average diameter of colonies

Treatment	Isolate	No. of CFU/g	Average Diameter of colony (cm)
Orange peel	*Aspergillus fumigatus*	3	2
	Aspergillus niger	1	4
	Aspergillus terreus	1	2
	*Mucor*sp.	2	2
Charcoal	*Aspergillus fumigatus*	2	1.5
	Aspergillus niger	1	3
	Aspergillus terreus	1	4
	*Mucor*sp.	2	2
control	*Aspergillus fumigatus*	14	2
	Aspergillus niger	9	5
	Aspergillus terreus	2	3
	Mucor sp.	25	2

DISCUSSION

Fungal species isolated from samples of *Irivingia* kernels preserved by alltreatment methods before storage were: *Aspergillus fumigatus, Aspergillus niger, Aspergillus terreus and Mucor* sp. This result is in agreement with the work of Etebu *et al*. (2012) who isolated four genera of fungi which

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include: *Aspergillus* sp., *Penicillium* sp., *Botrytis*sp. and *Mucor*sp. from postharvest *I. gabonensis* fruits. Fungal species often isolated from *Irvingia* kernels in storage are common group of fungi that infects grains after harvest and grows on them during storage (Amadi and Adeniyi, 2009). According toEtebu *et al* (2012) contamination of *Irvingia*kernels in storage was influenced by pre-storage treatment method. In their study*Mucor sp., Aspergillus niger, Aspergillus flavus* and *Rhizophora. stolonifer* were isolated from *Irvingia* kernels irrespective of the pre-storage treatment methods. The isolation of *C. tropicalis*, *Penicillium* and *Phytophthora* species were dependent on pre-storage treatment methods. However, *Penicillium* and *Phytophthora* species were not isolated from kernels that were sun-dried prior storage.

The result from this study didnot conform to the work of Etebu and Bawo (2013), which isolated 8 different species of fungi from stored kernel, as different treatment methods canaffect the chemical and physical composition of the kernels. This might be responsible for the variation in the fungal species that were able to colonize the kernels during storage. Ekpe et al. (2007) reported that fresh and processed *Irvingia* kernels subjected to different processing methods had significant differences in terms of protein, fat, ash and dietary fibre content.

Irvingia kernels stored in air -tight bottles without treatment had a higher fungal population than those stored in air-tight bottles subjected to treatments. Etebu (2012) reported that mean CFU of *Irvingia* kernels after 14 and 28 days of storage were 5.74 and 5.96 respectively. Amadi and Adeniyi (2009), reported that apart from reduction of market value, one major problem of postharvest spoilage of stored agricultural produce is the production of mycotoxins by species of spoilage fungi include *Aspergillus, Penicillium* and *Fusarium*. They reported that *Aspergillus* sp. and *Penicillium* sp. isolated from stored *Irvingia*kernels had a relatively high frequency of occurrence. Adebayo-tayo *et al*. (2006) detected aflatoxins (a type of mycotoxin) in *Irvingia gabonensis* kernels shelved for sale in Eastern Nigeria. The study also revealed that pre-storage treatment methods on postharvest fungal species is dependent on the condition of the kernels before storage. Local handlers of *Irvingia gabonensis* kernels attest that sun-drying the product is one of the predisposing factors for fungal disease severity. Therefore, sundried kernels should be allowed to cool properly before storing inside air tight containers to prevent moisture loss by condensation and re-absorption of oil released by kernels on exposure tosunlight.

More than 50% of Kernels stored in open bottles became completely discoloured when compared to those stored in air tight bottles with treatment. Trading on *irvingia* kernels is highly risky, as one could lose 75% of his/her investment to fungal attack. Fungal attack on *Irvingia gabonensis* kernels are majorly due to poor processing, especially sun drying, as maturation and abscission of the fruit takes place in the rainy season, during low sunshine. Processed *Irvingia gabonensis* kernels is sold to buyers who move from door to door in villages that are known to have forests where *irvingia gabonensis* trees grow. In southern Nigeria, the kernels are measured using 4 litres custard bucket which sell for about =N=6000 – =N=10,000 naira at the onset of the season but falls to =N=3000 – =N=4000 naira at the peak of the season.

CONCLUSION

Postharvest loss of *Irvingia gabonensis* kernels owing to fungal attack can be controlled, dependent on handling, treatment and storage method. Storing of *Irvingiaga bonensis* kernels inside air- tight containers with organic substances such as dried orange peels and charcoalcan reduce the severity of fungal attack.

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