Ghana J. Sci. **31-36,** (1991-96), 3-10

EVALUATION OF SOME TRADITIONAL CONTROL MEASURES FOR DISEASES OF STORED WHITE YAM, *DIOSCOREA ROTUNDATA* POIR VAR. GBOKO

K. A. ODURO, H. B. DAMPTEY AND L. O. ADIMORA

K.A.O.: Department of Crop Science, University of Ghana, Legon H.B.D.: Department of Botany, University of Cape Coast, Cape Coast L.O.A.: Rivers State University of Science & Technology, PMB 5080, Port Harcourt, Nigeria

Summary

In Nigeria and Ghana some farmers, as well as market women and house wives, use wood ash and palm oil to prevent rotting of stored yam. The two traditional control measures against rotting of stored white yam, *Dioscorea rotundata* Poir var. Gboko, were evaluated. Application of palm oil or wood ash to the cut surfaces of the yam tubers delayed or prevented the natural attack by five fungi: *Aspergillus niger,* three species of *Penicillium,* and *Rhizopus stolonifer.* Palm oil was, however, more effective than wood ash because it also prevented cracks that could serve as infection court on the cut surfaces. Both substances could inhibit the growth in culture of six earlier isolated fungal yam rotters.

Introduction

Yam is one of the most important food crops in West Africa, but its availability on the market fluctuates considerably throughout the whole region. In Nigeria, for example, there are usually, large supplies during the harvesting season and the period immediately after that, which may stretch from October to January, followed by a lean period when yams are scarce and very expensive. If yams could, therefore, be efficiently stored, a lot of the decay, which causes losses would be reduced.

Coursey (1967) attributed the greatest cause of post-harvest losses to attack by micro-organisms, which cause the tubers to rot. Prevention of rotting by these micro-organisms, especially the fungi, has been studied extensively. Wilson &Wickham (1982) reported that 0.5 *g/l* benomyl and thiabendazole effectively reduce the incidence of storage rots when applied as dips. *Penicillium oxalicum* was thus completely eliminated following such a treatment (Ricci, Coleno & Feure, 1978).

Curing tubers has also been reported to prevent, limit or delay rots. This method is particularly effective in sweet potatoes (Booth, 1974). The effect of the curing has been to encourage rapid wound healing through cell suberization and periderm formation.

Most published work on traditional methods of reducing disease losses have been on improved storage methods (Owueme, 1978). Other techniques such as application of wood ash and palm oil have received little or no attention. Lambert (1979) used wood ash to control rot pathogens on wounded yam in south states of New Caledonia.

In Nigeria and Ghana, the authors have observed and also learned through personal communication that wood ash and palm oil are used by some farmers, market women and house-wives to prevent rotting. The method has, however, not been scientifically evaluated.

This work is a report of the evaluation of the application of both wood ash and palm oil in controlling rot pathogens on white yam, *Dioscorea* *rotundata* var. Gboko, which is extensively consumed in Port Harcourt in Nigeria.

Experimental

Application of palm oil and wood ash on cut surfaces of yam tubers

Tubers of white yam, *D. rotundata* var. Gboko, which appeared healthy and similar in size and shape, were purchased from three major markets namely Mile 1, Mile 3, and Creek Road in Port Harcourt, Nigeria. Each tuber was cut along the circumference into two halves: a head region (bearing the vine) and a tail region. The three treatments were palm oil, wood ash application and control.

Thoroughly shaken palm oil purchased from the local markets was smeared on the exposed surfaces of the tubers with a surface-sterilized spatula. There after, the tubers were placed in upright position, with the cut surface up, for 30 min before placing them horizontally.

Wood ash, collected from a fireplace and sieved with 0.05 mm mesh sieve, was applied to the surfaces of the yams. With the cut yam surfaces in upright position, three spatulafuls of the ash were sprinkled on the surfaces until the entire area was covered. The spatula was used to evenly disperse the ash on the cut surface.

The control experiment consisted of tubers with the cut surfaces not treated with either palm oil or wood ash.

Each treatment was replicated five times and all the tubers were placed in well-ventilated rat-proof cupboards in the laboratory.

Determination of the growth of pathogens on media treated with palm oil or wood ash

The experiment had three treatments namely palm-oil-treated and wood-ash-treated media and control with five replicates in completely randomized design.

Merck's potato dextrose agar (PDA) was used as nutrient media. Fifteen millilitres (15 ml) of the melted media were poured into each sterile 90 mm petri dish and allowed to set. Palm oil (10 ml) was poured into each of the petri dishes which were then rocked gently until an even distribution of the oil on the PDA surface was obtained. This media was named palm oil potato dextrose agar (POPDA).

Three spatulafuls of wood ash were sprinkled onto the surface of solidified PDA. The plates were shaken to disperse the ash particles evenly. The media was named wood ash potato dextrose agar (WAPDA). The control consisted of only PDA plates.

Four-day-old cultures of *Aspergillus* sp., *A. niger, Botryodiplodia theobromae, Fusarium* sp., *Penicillium* sp., and *Rhizopus stolonifer* isolated earlier from rotten yam and maintained on PDA (Adimora, Oduro & Damptey, 1989), were each used to inoculate different plates in each treatment. Inoculum plugs were obtained with No.1 cork borer (5 mm) from the growing margin.

Results

Effect of palm oil and wood ash on susceptibility of cut yam tubers to rot causing pathogens

Results showed that 10 weeks after storage, only colonies of *A. niger* and *Pencillium* sp. were present on the oiled surface. *A. niger* appeared first by the 4th week while *Penicillium* sp. appeared by the 8th week. No cracks were observed on the oiled surfaces 10 weeks after treatment (Fig. 1). When the tubers were split open, both the head and tail halves were found to be rotted to the same depth of 2.9 cm.

Two different species of *Penicillium* and *Rhizopus stolonifer* developed on wood-ash-treated surfaces by the 6th week. Few cracks were observed when the ash was brushed off at the end of the experiment (Fig. 1). When the tubers were split open, the depth of rot measured 4.0 cm at both head and tail regions.

On control tubers, *Aspergillus* sp and *A. niger* were observed on the 2nd week. Two species of *Penicillium* also appeared by the by 4th week on the head region. *Rhizopus stolonifer* appeared by the 8th week but covered the entire surface area thereby masking the others. Numerous cracks appeared on the surfaces (Fig. 1). When the tubers were split open, rotting had extended to 4.1 cm in the head region and 3.5 cm in the tail.

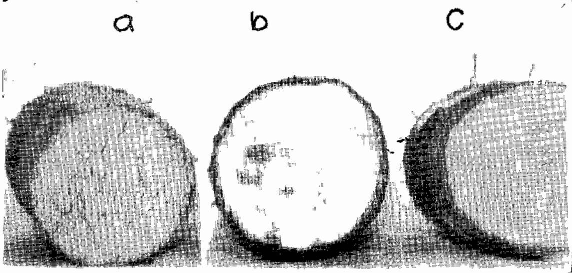

Fig. 1. Cut surfaces of yam tubers treated with palm oil, wood ash and untreated; and stored for 10 weeks.
(a) Untreated surface showing numerous cracks.
(b) Palm oil-treated surface showing no cracks.
(c) Wood ash-treated surface showing few cracks.

Effect of media treated with palm oil or wood ash on mycelial growth of the six pathogens

Data on the initial growth of the six fungal pathogens of the three media are presented in Tables 1-6. Two days after incubation, mycelial growth on the control media (PDA) of all the pathogens except *Aspergillus* sp. and *Penicillium* sp. were visible. The growth of these two fungi was delayed by 1 and 2 days respectively. The growth on POPDA and WAPDA media of the pathogens were delayed by 1-7 days. However, in the case of *Fusarium* sp., there was no growth on the oil media by the last day of the experiment.

After 10-days incubation, differences in mycelial growth on the various media were observed (Tables1-7). All the fungi except *R. stolonifer* grew significantly more on PDA than on either POPDA or WAPDA (P<0.01). The growth on the two treated media varied among the fungi. *Fusarium* sp. could not grow on the oil media while *Penicillium* sp.

TABLE 1

Diameter of Asperigillus *sp. on media treated separately with palm oil and wood ash**

Treatments	*Daily diameter growth (mm)*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10***
Palm oil potato dextrose agar (POPDA)	5.0***	5.0	5.0	5.0	5.0	7.25	8.1	15.0	18.0	25.2a
Wood ash potato dextrose agar (WAPDA)	5.0	5.0	5.0	5.0	5.0	5.0	12.0	21.0	27.0	27.0a
Control (PDA)	5.0	5.0	5.0	7.0	13.0	19.0	28.5	33.5	45.0	69.8b
LSD (5 per cent)										12.13
LSD (1 per cent)										12.43

* Experiment was complete randomized design with five replicates.
** (1) Experiment was terminated on the 10th day when growth on most control plates was complete.
(2) Means with the same letter are not significantly different.
*** All 5.0 mm represent the diameter of inoculum plug (i.e. no growth).

had a minute growth. Both, however, grew significantly more on the ash media ($P<0.01$). Similarly, *A. niger* grew more significantly on ash media than on oil media ($P<0.01$). No significant difference was observed between the growth on oil and ash media by either *Asperigillus* sp. or *B. theobromae* ($P<0.05$).

Asperigillus sp., *Fusarium* sp., and *Penicillum* sp. appeared to be slow growers. They could not cover the 90 mm PDA plates.

Discussion

Results from this work indicate that palm oil and wood ash can delay or prevent the attack of pathogens that cause decay of white yam, *D. rotundata* Poir var. Gboko.

For the tubers with cut surfaces, the depth of the rot arising from microbial action was greater on the untreated tubers and those treated with wood ash than on those treated with palm oil. Thus, palm oil was more effective in preventing rot. Further, only two species of fungi, *A. niger* and *Penicillium* sp. could eventually attack the palmoil-treated tubers. Tubers treated with ash were colonized by two species of *Penicillium* and *R. stolonifer*. However, all the five fungi attacked the untreated tubers.

The ability to prevent rots by palm oil and wood ash might be due to a microphysical barrier preventing direct contact of the fungi with the yam tubers. Another major contributing factor of the palm oil in controlling rot might be its ability to prevent cracks which could serve as infection courts for the fungi.

The use of palm oil and wood ash media to culture the six yam tuber rotters was aimed at ascertaining their effect on the pathogens. Both media could significantly inhibit the mycelial growth of the pathogens except *R. stolonifer,* but the oil performed better. Whereas *Penicillium* sp. was almost completely inhibited by the palm oil, *Fusarium* sp. was completely inhibited. These observations suggest that the oil had either a fungicidal or fungistatic property. It is also possible that most of these fungi lack lipase enzyme that could break down the oil. More work is needed to investigate the mechanism underlying the prevention of growth of the pathogens by palm oil.

The significant reduction of mycelial growth caused by wood ash could be due to the possible toxic compounds in the ash. Wood ash is the residue left after burning and elimination of organic compounds which constitute over 90 per cent of the dry matter of plants. It consists only of inorganic compounds which are incombustible. Although the quantity and quality of ash from different plants and plant parts vary greatly, analyses of wood ash show that over 40 well-known elements are present in it. The most constant ones are potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), sodium (Na), sulphur (S), phosphorus (P), chlorine (Cl), silicon (Si) and traces of manganese (Mn), zinc (Zn), copper (Cu), molybdenum (Mb) and aluminium (Dutta, 1981).

Elements such as sulphur and copper are well-known fungicides; chlorine is also a disinfectant. The presence of any of such elements could, therefore, inhibit the fungal growth. The wood ash used in this work was not analysed. This should be done in future work to ascertain the mechanism involved in the effect of wood ash on the fungal pathogens.

The data support the use of palm oil on cut surfaces of yam to prevent rotting. Palm oil has advantage over the conventional fungicides, which are generally toxic and expensive (Campbell *et al,* 1962). Palm oil is easily available, less expensive and edible.

On the other hand, although wood ash is cheap, easily available and could prevent the growth of fungi in culture, it could not prevent cracks on the cut surfaces of the white yam resulting in extensive rotting. More studies are, therefore, needed before it can be recommended.

TABLE 2

Diameter of growth of A. niger *on media treated separately with palm oil and wood ash**

Treatments	Daily diameter growth (mm)									
	1	2	3	4	5	6	7	8	9	10**
Palm oil potato dextrose agar (POPDA)	5.0 ***	5.0	5.0	6.0	6.5	6.5	12.5	16.0	21.0	22.9a
Wood ash potato dextrose agar (WAPDA)	5.0	5.0	5.0	7.0	15.0	25.0	32.0	26.0	40.0	41.0b
Control (PDA)	5.0	15.0	35.0	50.0	74.0	90.0	90.0	90.0	90.0	90.0c
LSD (5 per cent)										5.66
LSD (1 per cent)										6.97

TABLE 3

Diameter of growth of B. theobromae *on media treated separately with palm oil and wood ash**

Treatments	Daily diameter growth (mm)									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10***
Palm oil potato dextrose agar (POPDA)	5.0***	5.0	5.0	5.0	6.0	30.0	30.0	41.0	47.0	56.7a
Wood ash potato dextrose agar (WAPDA)	5.0	5.0	5.0	5.0	18.0	27.0	30.0	37.0	47.0	56.8a
Control (PDA)	5.0	23.0	50.0	79.0	87.5	90.0	90.0	90.0	90.0	90.0b
LSD (5 per cent)										16.63
LSD (1 per cent)										20.45

* Experiment was complete randomized design with five replicates.

** (1) Experiment was terminated on the 10th day when growth on most control plates was completed.
(2) Means with the same are not significantly different.

*** All 5.0 mm represent the diameter of inoculum plug (i.e. no growth).

TABLE 4
Diameter of mycelial growth of Fusarium *sp. on media treated separately with palm oil and wood ash**

Treatments	Daily diameter growth (mm)									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10***
Palm oil potato dextrose agar (POPDA)	5.0***	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0a
Wood ash potato dextrose agar (WAPDA)	5.0	5.0	7.0	9.0	9.0	12.0	15.0	15.0	18.0	21.0b
Control (PDA)	5.0	8.0	15.0	24.0	32.0	63.0	70.0	75.0	78.0	77.0c
LSD (5 per cent)										4.87
LSD (1 per cent)										5.97

TABLE 5
Diameter of growth of Penicillium *sp. on media treated separately with palm oil and wood ash**

Treatments	Daily diameter growth (mm)									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10***
Palm oil potato dextrose agar (POPDA)	5.0***	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.4a
Wood ash potato dextrose agar (WAPDA)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	19.0	26.4b
Control (PDA)	5.0	5.0	18.0	28.5	55.0	72.0	80.5	89.0	90.0	87.2c
LSD (5 per cent)										7.44
LSD (1 per cent)										9.15

* Experiment was complete randomized design with five replicates.
** (1) Experiment was terminated on the 10th day when growth on most control plates was completed.
(2) Means with the same letter are not significantly different.
*** All 5.0 mm represent the diameter of inoculum plug (i.e. no growth).

TABLE 6

Diameter of growth of R. stolonifer *on media treated separately with palm oil and wood ash**

Treatments	*Daily diameter growth (mm)*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10***
Palm oil potato dextrose agar (POPDA)	5.0***	5.0	8.0	23.5	40.0	41.0	52.0	62.0	72.5	84.6a
Wood ash potato dextrose agar (WAPDA)	5.0	5.0	20.0	31.0	35.0	40.0	43.0	43.0	47.0	48.6b
Control (PDA)	5.0	25.0		64.0	90.0	90.0	90.0	90.0	90.0	90.0
90.0c										
LSD (5 per cent)										41.49
LSD (1 per cent)										51.05

TABLE 7

*Summary of mycelial growth of six fungi in media treated separately with palm oil and wood ash after 10 days incubation**

Treatments	*Organisms*					
	Aspergillus *sp.*	A. niger	B. theobromae	Fusarium *sp.*	Penicillium *sp.*	B. stolonifer
POPDA	25.2a	22.9a	56.7a	5.0a	5.4a	84.6a
WOPDA	27.0a	41.0b	56.8a	21.0a	26.4b	48.6a
PDA	69.8b	90.0c	90.0b	77.0c	87.2c	90.0a
LSD (5 per cent)	12.13	5.66	16.63	4.87	7.44	41.49
LSD (1 per cent)	14.43	6.97	20.45	5.97	9.15	51.05

* Means with the same letter within the column are not significantly different.

References

ADIMORA, L. O., ODURO, K. A. & DAMPTEY, H. B. (1989) Studies of causal agents of rot in *Dioscorea rotundata* Poir var. Gboko. (white yam). *Ghana J. Sci.* **29-30**, 101-106.

BOTH, R. H. (1974) Post-harvest deterioration of tropical root crops: Losses and their control. *Trop. Sci.* **16**, 49-63.

CAMPBELL, J. S., CHUKWUEKE, V. O., TERIBA, F.A. HO-A-SHLL, H. V. S. (1962). Some physiological investigation with white Lisbon yams, *D. Alata*. III: The effects of chemicals on storage. *Emp. J. exp. Agric.* **30**, 335-344.

COURSEY, D. G. (1967) Yam storage. L. A. review of yam storage practices and information on storage losses. *J. Stored Prod. Res.* **2,** 229-244.

DUTTA, A. C. (1981) *Botany for degree students.* Oxford: University Press.

LAMBERT, M. (1979) Storage and processing of root crops in the South Pacific, pp. 47-52. In *Small scale processing and storage of tropical agriculture series.* (ed. D . K. Pluknett). Boulder Colorado: West View Press

OWUEME, I. C. (1978) *The tropical tuber crops: Yams, cassava, sweet potato and cocoyam.* Cherchester: John Wiley & sons.

RICCI, P., COLENO, A. & FEURE, F. (1978) Storage problems of cush-cush yams II. Control of *Penicillium oxalicum* rots. *Ann. Phytopath.* **10.** 433-440.

WILSON, L. & WICKAM, L. (1982) Gibberellic acid dip slows yam decay. In *International Agricultureal Development* (ed. H. C. Passam). pp. 10-11.

Received 5 July 90; revised 5 June 91.