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THE EFFICACY OF BOTANICAL PROTECTANTS IN THE STORAGE OF COCOYAM (*COLOCASIA ESCULENTA* (L) SCHOTT)

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ABSTRACT
Aqueous extracts made from Ocimium basilium L., Vernonia amygdalina Del., Azadirachta indica L. and Carica papaya L. at different concentrations (150g/l and 300g/l) were used to study their effects on corm fresh weight loss, rotting and sprouting of two cocoyam varieties (Colocasia esculenta var. "Ede Ofe" and var. Ugwuta"). All the aqueous extracts at both 150g/I and 300g/I reduced fresh weight loss and rotting of corms in both varieties better than in water control. O. basilium L. at both 150g/I and 300g/I significantly reduced fresh weight loss and rotting of corms in both varieties compared to all other extracts and also promoted higher sprouting in both varieties at 300g/l. C. esculenta var. "Ede ofe" had less weight loss, rotting of corms (i. e. were more storable) and less sprouting than C. esculenta var. "Ugwuta".

Key Words: Botanical Protectants, Extracts, Storage, Cocoyam.

INTRODUCTION

Cocoyam (*Colocasia esculenta* (L) Schott) is a herb and belongs to the family, Araceae and is commonly referred to as taro (Dutta, 1990). It is a root crop cultivated mainly for the edible corms, though the leaves, petioles and flowers are used in soup preparation (Eze and Maduewesi, 1990). The corms and cormels can be boiled or baked and consumed in different forms as, soup thickener, pounded *foofoo,* roasted in fire, as porridge and biscuit (achicha) (Ajala and Obiechina, 1987). Coco yams are rated third among the staple tuber crops eaten in Nigeria (Onwueme, 1998).

Harvested cocoyams are stored by different methods to extend their shelf life for the next planting season and for subsequent use as food. A good percentage of cocoyams are lost due to rots, weight reduction and loss of viability during storage. Gollifer and Booth (1993) reported that harvested cocoyams rotted two weeks later in British Solomon Islands protectorate.

A number of fungal organisms have been implicated in the storage rotting of coco yams and they include, *Aspergillus niger, Fusarium* solani, *Botryodiplodia theobromae, Fusarium oxysporum, Corticium rolfsii, Geotrichum candida* and *Sclerotium rolfsii* (Trujillo, 1967; D' Suoza and Moniz, 1968; Gollifer and Booth, 1973; Onwueme, 1978; Ugwuanyi and Obeta, 1996).

Eze and Maduewesi (1990) recommended that harvested cocoyams should be stored in pits or heaped on the ground in the barn to reduce ros and ensure viability of the corms.

Over the years the protection of agricultural crops and products was achieved almost entirely through the use of synthetic chemicals (Adams, 1991). These chemicals though valued for their effectiveness are costly and may constitute health hazards to farm households and the environment.

Several workers have demonstrated the efficiency of botanical fungicides/extracts on the control of post harvest rots in plant products (Sowumi and Akinnusi, 1983; Pandey *et al,* 1983; Uzuegbu and Okoro, 1999; Thangavelu, *et al,* 2004; Onyeke and Maduewesi, 2006). Report on the effect of botanical extracts on weight and sprouting of harvested products is lacking.

The aim of the present work was to determine the effects of extracts from *Vernonia amygdalina*, *Ocimim basilium, Azadirachta indica* and *Carica papaya* on the weight, sprouting and rotting of harvested corms of two cocoyam (C. *esculenta*) varieties in storage.

MATERIALS AND METHODS

The studies were conducted in 2005 and 2006 in the storage field of the Department of Crop Science, Faculty of Agriculture, University of Nigeria, Nsukka (Latitude 06^0 25'^{N}, Longitude 07^0 24'^{E}, Altitude 447. 26M above Seal Level). Daily temperatures and relative humidities were recorded. In 2005, mean maximum and minimum temperatures were 33.82 and 22.14, respectively. Mean relative humidity was 64.34. In 2006 mean maximum and minimum temperatures were 33. 29 and 23.05, respectively. Mean relative humidity was 67.01.

Sources of Cocoyam (*Colocasia esculenta* (L) Schott and Botanical Extracts.

Freshly harvested corms and cormels of the two varieties of cocoyam (*C. esculenta* var, "Ede ofe" and *C. esculenta* var. "Ugwuta") were collected from the experimental farm of the Department of Crop Science, University of Nigeria, Nsukka. The corms and cormels were taken immediately to the farm house where the experiments were conducted.

The fresh leaves of *Vernonia amygdalina* Del. (VA), Ocimium *basilium* L. (OB), *Azadirachta indica* A: Juss (A1) and *Carica papaya* L. (CP) were also collected from the experimental farm of the Department of Crop Science, University of Nigeria, Nsukka.

Preparation of Aqueous Extracts.

The fresh leaves of *V. amydalina, O. basilium, A. indica, C. papaya* were washed clean with tap water, rinsed with sterile distilled water and allowed to dry in an oven at the temperature of 45± 2^0C to make them brittle. The dried leaves were ground to fine powder in a mortar and sieved with 2mm sieve.

The sieved powder of each plant type was separated into various weights of 150g and 300g. The powder was each diluted with one litre of sterile distilled water to give 150g/l and 300g/l solutions of the treatments. These mixtures were left to stand for 24hr after which they were filtered with cheese cloth and the filterates (aqueous extracts) were collected in clean plastic containers for immediate use.

Storage Experiments.

The experiment was laid out as 9 x 2 factorial in completely randomized design (CRD) replicated three times. The two cocoyam varieties were separated into portions of 2kg weights. Each 2kg weight of cocoyam was treated by steeping for 2 minutes in the crude extract and thereafter put in plastic basket and labelled. They were randomly laid out on the benches in the farm house and observed for 3 month - (January through March) for two consecutive years (2005 through 2006). Data were collected on the weight, percentage rot and percentage sprouting at the end of the three months storage periods. For the control experiments, sterile distilled water was used in place of crude plant extracts.

Determination of fresh weight loss.

This was done using a modified method of Eze and Maduewesi (1990). The weight (g) loss of each of the two cocoyam varieties was determined thus:

Initial weight (g) mean – Final weight (g) mean,

Determination of percentage rot Incidence:

The percentage rot incidence was determined using the method of Gollifer and Booth (1973):

$$\frac{\text{Number of corms rotted x 100}}{\text{Total number of corms sampled}}$$

Determination of percentage sprouting.

This was obtained by applying the same formular as was used in determination of percentage rot incidence:

$$\frac{\text{Number of corms sprouted x 100}}{\text{Total number of corms sampled}}$$

RESULTS

Determination of Fresh Weight Loss

The effects of botanical aqueous extracts on weight (g) of the two varieties of cocoyam during storage are shown on Table 1.

Table 1: Effects of aqueous extracts on the fresh weight (g) loss of *C. esculenta* var. 'Ede ofe' and var. 'Ugwuta' after 3months in 2005 and 2006.

		2005 Cocoyam varieties			2006 Cocoyam varieties		
Extracts	Concentration (g/I)	'Ede ofe'	'Ugwuta'	Mean	'Ede ofe'	'Ugwuta'	Mean
AI	150	16.0	26.0	21.0	21.8	39.6	30.7
AI	300	14.0	15.0	14.5	18.9	25.7	22.3
CP	150	19.8	50.0	34.8	21.9	21.6	21.8
CP	300	13.0	15.5	14.3	18.4	22.1	20.3
VA	150	20.0	27.0	23.5	22.1	35.1	28.7
VA	300	13.0	16.5	14.6	21.4	34.9	28..2
OB	150	13.0	15.0	14.0	11.5	25.6	18.6
OB	300	10.0	11.0	10.5	13.7	22.1	17.9
Control		26.0	28.3	27.1	21.8	38.6	30.2
Mean		16.1	22.7		19.1	29.5	

	2005	2006
F- LSD (P=0.05) for comparing Botanical Extracts and their Concentrations	0.710	0.696
F- LSD (P=0.05) for comparing Cocoyam varieties	0.335	0.328
F- LSD (P=0.05) for comparing Botanical Extracts and their Concentrations x Cocoyam var. interactions	1.004	0.985

The results on Table 1 showed that *C. esculenta* var. "Ugwuta" had the highest mean weight loss of 22.7g and 29. 5g from all treatments in 2005 and 2006, respectively. This differed significantly (P=0.05) from that of "Ede ofe" which recorded the lowest mean weight loss of 16.1g and 19.1g in 2005 and 2006, respectively.

C. papaya (CP) extract (150g/l) gave the highest mean weight loss of 34.8g in 2005 in the two varieties while *A. indica* (AI) extract (150g/I) gave the highest mean weight loss of 30. 7g in 2006. *O. basilium* (OB) extract (300g/I) produced the lowest mean weight loss of 10.5g and 17.9g in 2005 and 2006 respectively. This result also showed that the activity of the extracts against weight loss increased with increase in concentrations

Determination of percentage rot Incidence.

Results on the effect of botanical extracts on percentage rot incidence of two cocoyam varieties are shown in Table 2.

Table 2: Effect of the botanical aqueous extracts on the percentage rot incidence of *C. esculenta* var. "Ede ofe" and var. "Ugwuta" after 3 months of storage in 2005 and 2006.

		2005 Cocoyam varieties			2006 Cocoyam varieties		
Extracts	Concentration (g/I)	'Ede ofe'	'Ugwuta'	Mean	'Ede ofe'	'Ugwuta'	Mean
AI	150	11.9	12.0	12.0	11.7	20.0	15.9
AI	300	10.5	10.7	10.6	5.80	13.3	9.53
CP	150	11.9	18.6	15.2	11.7	26.6	19.2
CP	300	9.40	10.9	10.1	5.50	17.8	11.7
VA	150	16.8	18.3	17.6	20.6	25.8	23.2
VA	300	11.1	16.0	13.6	17.6	20.7	19.2
OB	150	5.20	7.80	6.50	5.80	11.7	8.80
OB	300	3.00	4.30	3.70	3.30	9.50	6.40
Control		26.1	29.2	27.7	26.6	30.7	28.8
Mean		11.8	14.2		12.1	19.6	

	2005	2006
F- LSD (P=0.05) for comparing Botanical Extracts and their Concentrations	0.553	1.337
F- LSD (P=0.05) for comparing Cocoyam varieties	0. 261	0.630
F- LSD (P=0.05) for comparing Botanical Extracts and their Concentrations x Cocoyam var. interactions	0.782	1.890

The results showed that *C. esculenta* var. "Ugwuta" had the highest percentage rot incidence of 14. 2% and 19.6% in 2005 and 2006, respectively. This differed significantly (P=0.05) from that of "Ede ofe" which recorded a lower percentage rot incidence of 11.8% and 12.1% in 2005 and 2006, respectively.

The results also showed that all the aqueous extracts generally exhibited decreasing levels of activity against rot incidence in the two cocoyam varieties. *V. amygdalina* (VA) extract (150g/l) recorded the highest percentage rot incidence of 17.6% and 23.2% in 2005 and 2006, respectively. This differed significantly (P=0.05) from that of *O. basilium* extract (150g/l) which gave the lowest percentage rot incidence of 6.50% and 8.80% in 2005 and 2006, respectively. *O. basilium* extract (300g/l) gave the lowest percentage rot incidence of 3.7% and 6.40% in 2005 and 2006, respectively. This differed significantly (p=0.05) from that of *V.amygdalina* (VA) extract (300g/l) which produced higher percentage rot incidence of 13.6% and 19.2% in 2005 and 2006, respectively.

Determination of Percentage Sprouting

Table 3: Effects of botanical aqueous extracts on the percentage sprouting of *C. esculenta* var. 'Ede ofe' and var. 'Ugwuta' after 3 months of storage in 2005 and 2006.

		2005 Cocoyam varieties			2006 Cocoyam varieties		
Extracts	Concentration (g/I)	'ede ofe'	Ugwuta	Mean	'ede ofe'	Ugwuta	Mean
AI	150	7.50	11.5	9.51	9.60	10.5	10.1
AI	300	14.4	14.5	14.5	13.5	14.5	14.0
CP	150	7.14	10.4	8.80	5.80	12.5	9.20
CP	300	7.80	12.4	10.1	11.6	13.6	12.6
VA	150	2.81	4.40	3.60	16.5	12.5	14.5
VA	300	6.70	5.80	6.21	17.5	14.7	16.1
OB	150	10.8	8.60	9.64	12.6	14.6	13.6
OB	300	16.8	15.1	15.9	18.7	20.6	19.6
Control		12.2	10.5	11.3	10.5	11.5	11.0
Mean		9.60	10.4		12.9	13.9	

	2005	2006
F- LSD (P=0.05) for comparing Botanical Extracts and their Concentrations	0.697	0.625
F- LSD (P=0.05) for comparing Cocoyam varieties	0. 328	0.295
F- LSD (P=0.05) for comparing Botanical Extracts and their Concentrations x Cocoyam var. interactions	0.985	0.884

The results in Table 3 showed that 'Ugwuta' had the highest percentage sprouting of 10.4% and 13.9% in 2005 and 2006, respectively while 'Ede Ofe' recorded the lowest percentage sprouting of 9.60% and 12.9% in 2005 and 2006, respectively.

The results also showed that some of the extracts enhanced sprouting significantly (P=0.05) while others retarded sprouting significantly (P=0.05). *O. basilium* extract (300g/l) produced the highest percentage sprouting of 15.9% and 19.6% in 2005 and 2006 respectively. *V. amygdalina* extract (300g/l) suppressed percentage sprouting to 6.20% in 2005 and 16.1% in 2006. *V. amygdalina* extract (150g/l) caused the lowest percentage sprouting of 3.60% in 2005 while *C. papaya* extract (150g/l) caused lowest percentage sprouting of 9.20%.

DISCUSSION

Results have shown that there was a general loss in fresh weight in the two varieties of cocoyam during storage. *C. esculenta* var. 'Ugwuta' significantly (P=0.05) lost more fresh weight as against 'Ede Ofe'. This observed significant loss in fresh weight of cocoyam varieties could be attributed to the biochemical, physiological and respiratory activities taking place in the corms (Coursey and Russel, 1969; Praquin and Miche, 1971; Chinsman and Fiagan, 1987). *O. basilium* extract (300g/l) proved to be very effective in the control of loss of fresh weight in the cocoyams. Similar result on the control of loss of fresh weight in cocoyams using ashes from the bark of kolanut tree; neem tree and inflorescence of oil palm has been reported earlier (Eze, 1991). This result shows that *O. basilium* may have some suberizing activities on points of

bruises and as such reduces water loss from the corms (Coursey, 1967a; Coursey, 1967b).

Results on percentage rot incidence are in conformity with several reports of various workers on the storage rots of cocoyam both in Nigeria and elsewhere (Gollifer and Booth, 1973; Jackson and Gollifer, 1975). Ogundana, 1976a; 1976b; Maduewesi and Onyike, 1981; Ugwuanyi and Obeta, 1996). *C. esculenta* var 'Ugwuta' rotted more than *C. esculenta* var. 'Ede ofe' in both years. This significant (P=0.05) difference in percentage rot incidence in both varieties could be attributed to their biochemical food composition (Oyenuga 1968). *O. basilium* extract (300g/I) was the most efficacious in the control of the post harvest rotting of cocoyams as it reduced percentage rot incidence to a very low level of 3.70%. Fungi causing cocoyam rots have been shown to produce pectinolytic and cellulolytic enzymes, which degrade cell wall polymers and as such make available carbon sources for the attacking organisms (Ugwuanyi and Obeta, 1996). Similar results have been achieved using other plant extracts (Sowumi and Akinnusi, 1983; Pandey *et al*., 1983; Uzuegbu and Okoro, 1999; Thangavelu et al., 2004; Onyeke and Maduewesi, 2006) and ashes (Eze, 1991) for the contol of post harvest rotting in plant products. *O. basilium* extract could, perhaps possess active principle(s) against either the pathogen or the pectinolytic and cellulolytic enzymes produced by the pathogen or both. The percentage sprouting recorded in *C. esculenta* var. 'Ugwuta' which was higher than that of 'Ede ofe' was expected since it lost the highest fresh weight and this loss in fresh weight could be attributed to the physiological losses associated with sprouting (Praquin and Miche, 1971). *O. basilium* extract (300g/l) enhanced sprouting in cocoyam varieties, *V. amygdalina* extract (150g/l) retarded sprouting in both years.

This has indicated the usefulness of *O. basilium* extract (300g/l) for the treatment of corms ready for planting to induce sprouting. Conversely, *V. amygdalina* could be useful in delaying sprouting in corms that will not be used immediately for planting. Meanwhile, Williams (1986) reported that wood ash paste and filterates did not inhibit sprouting in yam tubers.

Relative humidity and temperature play role in determining the rate of water loss in evapotranspiration and on the crop physiological activities with higher fluctuation enhancing higher physiological activities. The period of these experiments coincided with the peak period of these biodegradation factors and identifying botanical extracts for effective control of cocoyam rot within these periods is an important finding.

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