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Application of a Low-Cost Storage Technique for Fresh Cassava (*Manihot esculenta*) Roots in Ghana

Utilisation d'une technique de stockage bon marché pour les racines de manioc fraîchement récoltées au Ghana

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- Abstract -

A series of experimental on-farm storage trials was carried out in Ghana to determine whether the application of water or fungicide (thiobendazole) to freshly harvested cassava roots prior to or during storage in either polyethylene bags or recycled rice sacks (woven polyethylene) could prolong the storage life of the produce. Results indicate that, if applied early enough, under ambient conditions the surroundings engendered by these treatments were sufficient to prolong the storage life of the roots from 3-5 days to 2-3 weeks. Water treatments alone in combination with either bags or sacks helped maintain the storage potential of the cassava for at least 7 days provided that microbial infection was avoided. Thiobendazole was found to not only suppress fungal rots but also enhanced the storability of the roots to an even greater extent than water alone.

- Résumé -

Une série d'essais expérimentaux a été menée dans des fermes au Ghana afin de déterminer si l'application, avant ou pendant le stockage, d'eau ou de fongicide (thiobadenzole) à des racines fraîchement récoltées contenues dans des sacs en polyéthylène ou dans des sacs de riz recyclés (polyéthylène tissé) pouvait prolonger leur durée de stockage.

Les résultats indiquent que s'ils sont appliqués suffisamment tôt, tous ces traitements créent des environnements capables de prolonger la durée de stockage des racines de 3 à 5 jours jusqu'à 2 à 3 semaines. Les traitements utilisant seulement de l'eau dans des sacs en polyéthylène ou recyclés peuvent prolonger les possibilités de stockage d'au moins 7 jours à condition que la contamination

Introduction

The characteristics of cassava (*Manihot esculenta Crantz.*) that have lead to its extensive cultivation particularly in Central and South America, South East Asia and Africa are; its relative ease of vegetative propagation, its low maintenance demands following establishment, its drought tolerance and its ability to produce yields over an extended harvesting period even on nutrient poor, marginalised soils without recourse to chemical inputs (Kay, 1987).

Set against these attributes is the extreme perishability of the fresh roots following harvest. In the absence of an infrastructure that may support refrigeration or waxing of roots, fresh produce will begin to deteriorate within 3 to 5 days (Rickard, 1985). Working within these constraints many communities have developed marketing and processing strategies to either rapidly disperse fresh cassava roots to consumers or to convert them into dry stable products amenable to storage and subsequent transportation and distribution (NRI, 1992).

The traditional systems of handling cassava have served communities well, however, with changes in lifestyles and increasing urbanisation, it will become increasingly difficult for traders to ensure the delivery of high quality fresh cassava roots to commercial or domestic clients at a distance from areas of production. A cheap and robust system capable of delaying the onset of post-harvest deterioration in cassava roots would not only increase the flexibility of the marketing systems but also reduce wastage.

In the 1980's scientists from the Centro Internacional de Agricultura Tropical (CIAT) and the Natural Resources Institute (NRI) developed and promulgated a relatively simple low-cost fresh cassava storage technique in Colombia and other states in Latin America (CIAT, 1992).

The system is based on the timely storage of high quality, fresh cassava roots in polyethylene bags combined with the application of the fungicide; thiobendazole (available as TECTO). The warm, moist environment engendered by cassava roots held in polyethylene bags under moderate ambient conditions in the tropics stimulates a curing and wound-healing response in freshly harvested roots that enhances the storage potential of the material by decreasing the rate of natural physiological deterioration. The use of the fungicide markedly reduces the frequency of deleterious fungal infections that might otherwise impair the quality of stored roots. When adopted successfully the storage life of cassava roots may be extended from 3 - 4 days to 2 - 3 weeks (Ciat, 1989).

In this paper findings of on-farm storage trials are reported which form

Materials and Methods

Over a 3-month period, during the summer rains of 1993, factorial experiments were conducted in the Asanti Region of Ghana. These storage trials were undertaken at one village location and were designed to assess the response of locally popular cassava cultivars to different interpretations of the low-cost storage methodology. Routinely cassava was harvested from sites established on forest soils and then, after treatment, the roots were stored in dark, well ventilated but enclosed rooms with concrete walls and floors surmounted by corrugated iron roofs.

At harvest considerable care was taken to avoid damage to the roots and, in accordance with the protocols advocated by CIAT, only particular categories were selected for storage (CIAT, 1989). Those exhibiting superficial wounds could be conserved provided any damaged tissues could be trimmed away leaving a clean cut surface. Roots that were crushed, bruised or split or showed signs of gashes or invasive wounds especially at the stem end were not used in the storage trials.

Depending on experimental design (Table 1), different consignments of cassava were subjected to contrasting wash treatments. Some were kept dry, some

Table 1

investigate the influence of different storages containers and wash treatments on the extent of micro-iological and physiological deterioration of fresh cassava roots

torial Treatments							
ntainers gs or sacks)		Washes			Application		
Open-weave Polyethylene	Recycled Rice	Dry (unwashed Water		Thiobendazole	Dip (d)	Spray (s)	Comments
1	-	1	1 (d)	1 (d or s)	1	1	Application of all treatments within 6 h of harvest
) 1 (i or ii)	-	1	1 (d)	1 (d)	1 (i or ii)	-	Application of wash treatments and bagging within either (i) 1 h of harvest or (ii) after 24 h
) 1 (i)	-	1	1 (s)	1 (s)	-	1 (i , ii or iii)	Bags applied on day 0. Sprays applied on (i) day 0, (ii) day 1 or (iii) day 2
1 (i or ii)	-	-	1 (d)	1 (d)	1	-	Wash treatments applied on day 0. (i) Polyethylene bags applied after harvest and retained throughout or (ii) bags removed 4 days after harvest
1	1	-	1 (d)	1 (d)	1	-	Wash treatments and bags applied immediately after harvest
1	1	1	1 (d)	1 (d)	1	-	Wash treatments and bags applied immediately after harvest

cassava roots held together in one or other of the sack treatments. When data were collected, the contents of 3 replicate sacks were destructively assessed for each of the particular factorial treatment combinations of interest.

The effect of the experimental treatments on the quality of the stored cassava was determined by dissecting the roots and allocating scores to the level of apparent physiological and micro-biological deterioration found within.

Routinely, the contents of each sampling unit was removed and the roots ranked in order of length. The longest and shortest roots were discarded in Trials 1 to 4 while in Trials 5 and 6, every other root was de-selected. Each of the 4 remaining roots were then cut into 4 segments of equal length. Finally, each of the two end

Results of Trial 2 indicate that cassava placed in bags immediately after harvest maintained their quality into the third week of storage. A delay in the use of polyethylene bags by 24 h resulted in higher levels of microbial rot. This disparity was not obvious after 8 days in store but became significant ($P<0.05$) after 15 days. The level of physiological deterioration in such roots also increased.

Additional studies suggested that provided roots are allowed to 'cure' in warm, humid conditions for a period of 4 days immediately after harvest, they can then be removed and held under ambient conditions for at least a further 10 days without a significant loss of quality (Trial 4).

The manner in which fresh cassava responded to various wash treatments indicated that the water and thiobendazole dips or sprays profoundly enhanced the storage life of the roots. Moreover, the application of thiobendazole not only had the desired effect of depressing the rate of microbial deterioration, in all trials, but also could often retard the symptoms of physiological deterioration to a greater extent than water treatments alone ($P<0.001$, Trial 1).

Water treatments suppressed symptoms of post-harvest deterioration relatively efficiently for period of about a week (Trials 5 and 6). Thereafter, although physiological scores may remain acceptably low, the incidence of microbial spoilage tended to rise in comparison to thiobendazole treated roots ($P<0.001$, Trials 1 and 5). Provided cassava roots are placed in polyethylene bags soon after harvest, the efficacy of either water or thiobendazole treatments is not influenced by the mode of application or a delay of such applications for up to 2

Table 2

The influence of different factorial treatments on the extent of micro-biological and physiological deterioration of fresh cassava roots held in store (Part 1).

	Variables	Factorial Treatments										Contrasts	Standard Error
			Assessment	Day	Containers & Wash Treatment							(between levels)	
Trial No.		Main Effects			Contrast Codes: 1	2	3	4	5	6	7		
		Containers	Levels		OW	P							
1	Phys.				4,50	2,20						All	0,67
	Micro.				3,60	1,90						All	0,65
		Washes	Levels		D	W (d)	T (d)	T (s)					
	Phys.				4,90	3,70	1,60	2,00				All	0,63
	Micro.		7		2,90	1,70	1,20	1,40				All	0,68
			13		4,30	3,50	1,80	1,20					
		Containers	Levels		OW	P (i)	P (ii)						
2	Phys.				3,40	2,00	2,30					All	0,33
												2 v 3	0,27
	Micro.		8		2,70	1,50	1,70					All	0,70
			15		3,50	1,40	2,30					2 v 3	0,57
		Washes	Levels		D	W (d)	T (d)						
	Phys.				3,70	2,40	2,00					All	0,32
												2 v 3	0,26
	Micro.				3,10	2,00	1,40					All	0,41
												2 v 3	0,33
		Containers	Levels		OW	P							
3	Phys.				4,00	2,40						All	0,36
	Micro.				3,20	1,90						All	0,36
		Washes	Levels		D	T (i)	W (i)	T (ii)	W (ii)	T (iii)	W (iii)		
	Phys.				4,00	2,40	2,50	2,00	2,50	2,30	2,50	All	0,55
	Micro.				3,20	2,00	2,00	1,60	2,00	1,70	1,90	All	0,56
		Containers	Levels		OW	P (a)	P (b)						
4	Phys.		7		3,30	2,10	2,10					1 v (2&3)	0,58
			14		4,50	2,40	2,50					2 v 3	0,47
	Micro.		7		2,40	1,70	1,60					1 v (2&3)	0,60
			14		3,80	2,00	2,00					2 v 3	0,49
		Washes	Levels		D	T (d)	W (d)						
	Phys.		7		3,30	2,10	2,20					1 v (2&3)	0,42

Table 3

The influence of different factorial treatments on the extent of micro-biological and physiological deterioration of fresh cassava roots held in store (Part 2).

	Variables	Factorial Treatments							Contrasts	Standard Error
			essment	Containers & Wash Treatment					tween levels)	