EFFECTS OF CHEMICAL SPROUT INHIBITORS ON THE POSTHARVEST QUALITY OF GUINEA WHITE YAM (*Dioscorea rotundata* Poir) TUBERS.

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ABSTRACT

Yam (Dioscorea spp), plays a very important role in the daily diet of roughly 200 million people in West Africa, therefore a year round supply in markets is highly desirable and profitable for producers and traders. However, losses due to physiological processes, rots and pests can be considerable and constitute a major threat to the economic viability of yam storage. In order to ensure all-year-round yam availability, an experiment was conducted to evaluate the performance of chemical sprout inhibitors (gibberellic acid, maleic hydrazide, extract of neem leaves and distilled water) in the postharvest storage of yam (Dioscorea rotundata) tubers. The experiment was laid out in a completely randomized design with three replicates. The parameters measured were number of sprouts, sprout weights, sprout lengths and percentage weight loss. The results showed that all the chemical sprout inhibitors reduced the number of sprouts, vine length, vine weight and weight loss of stored yam tubers better than the control. Neem leaf extracts (NLE) significantly ($p \leq 0.05$) suppressed number of sprouts throughout the storage period. However, yam tubers treated with gibberellic acid (GA_3) recorded the least values in terms of vine length (26.14), vine weight (43.44 g) and percentage weight loss (32.42%) at the end of the storage period. Thus, it could be concluded that NLE and GA_3 as sprout inhibitors may have a great commercial potential to prolong the shelf life of stored yam tubers and reduce economic losses.

Keywords: Dioscorea, sprout inhibitors, weight loss, gibberellic acid, vine, storage.

INTRODUCTION

Yam (Dioscorea spp), plays a vital role in the daily diet of around 200 million people in West Africa (Tschannen, 2003). Significantly, yam contributes to food security in Nigeria and its availability on the market for considerable parts of the year helps prevent food shortages, particularly in urban communities. The income generated by rural poor farmers who are engaged in yam production improves their living standards. Yam is an annual crop, therefore, for it to be available throughout the year; harvested tubers must be stored for six to eight months before new yams are harvested. Storage influences availability of yam for consumption between January to August. Losses due to physiological processes, rots and pests can be considerable and constitute a major threat to the economic viability of yam storage and food security of the population concerned.

Yam tubers are dormant after harvest and few losses occur. The storage life of yam tubers is ended at the termination of dormancy, when new sprouts develop. Once sprouting begins, reserves are rapidly depleted as respiration increases and a large, inedible sprout is formed. Sprouting causes weight and quality loss in stored yam since all its "ingredients" must have originated from the tuber (Osunde and Orhevba, 2009). These physiological changes affect the internal composition of the tuber and result in destruction of edible materials, which under normal storage condition can often reach 10% after 3 months, and up to 25% after 5 months of storage (Passam*et al.*, 1978).

Therefore, in order to have all-year-round yam for diverse uses, the method of proper storage should be well investigated. A number of treatments and techniques have been developed to reduce these physiological activities and also to protect the tubers from post harvest losses. These include treatment with chemicals such as gibberellic acid, maleic hydrazide, methyl ester naphthylacetic acid, plant extracts and gamma irradiation. It is therefore of interest to determine the effects of these chemicals and the potentials of neem leaves extracts on the postharvest quality of stored yam tubers.

MATERIALS AND METHODS

Experimental Location

The experiment was carried out in 2013 in the Postharvest Technology laboratory of Federal College of Horticulture, Dadinkowa, Gombe State, Nigeria(latitude 10^0 18'N and longitude 11^0 18'E). The annual rainfall of the area is 800 mm with mean daily temperatures ranging from 30^0 C to 36^0 C (Kowal and Knabe, 1979).

Storage Experiment

For the purpose of this experiment, arrangement was made with yam sellers to supply tubers of the same physiological age and species. Visually healthy yam tubers were sorted and transported to the laboratory. They were divided into four groups consisting of twelve yam tubers. The first three groups were treated with solutions of gibberellic acid, maleic hydrazide, neem leaf extracts while the fourth group was treated with distilled water (control) Each yam tuber was treated with the respective chemical solutions by dipping the head regions (where sprouting naturally begins) in the solutions for three hours, removed and allowed to dry and thereafter put on the wooden shelves and labeled. Yam tubers were laid out in a completely randomized design replicated three times. They were randomly laid out on the shelves in the laboratory for six months. Data were collected on the number of sprouts, vine length, vine weight and percentage weight loss at monthly intervals. For the control experiment, sterile distilled water was used in place of chemical solutions.

Preparation and Application of Chemicals

One gram of each of the chemical sprout inhibitors was dissolved in 1000 millilitre of sterile distilled water in 1-

litre capacity round bottom flasks. The flasks were corked and shaken for five minutes, and allowed for 24 hours to dissolve completely with shaking at intervals. To prepare the aqueous extracts of neem leaves, freshly harvested neem leaves (*Azadirachta indica)* were collected, washed with clean tap water and air-dried to crispy condition. The dried leaves were ground to fine powder in a mortar and sieved with 2mm sieve. The powder was weighed (20 g) and diluted with one litre of sterile water to give 20 g/l solutions. The mixture was left to stand for 24 hours after which it was filtered with cheese cloth and the filtrates was collected in a clean plastic container.

Data collection

Determination of number of sprouts/tuber

The number of sprouts per tuber was physically counted every month by careful observation of sprouted tubers.

Measurement of vine weight (g)

Sprouts from tubers were de-sprouted every month and weighed on a digital weighing balance to determine the vine weights of tubers.

Measurement of sprout length (cm)

Vine lengths of the sprouted tubers were measured and recorded at monthly intervals. This was done by placing a meter rule against the vine, from the base to the apex.

Evaluation of percentage weight loss

The weight of each yam tuber was taken and recorded before the commencement of the experiment. Subsequent weights were taken as well at monthly intervals and the difference between weights represents the monthly loss. Weights were measured with a weighing balance sensitive to 1g and 2 kg capacity. The percentage weight loss for each month was computed based on the initial tuber weight as follows:

$$\text{Percentage weight loss} = \frac{\text{Difference between initial and successive weights}}{\text{Initial weight of tuber at the start of storage}} \times 100$$

RESULTS

Effect of chemical sprout inhibitors on the number of sprouts of stored yam tubers

The mean values of the effects of chemical sprout inhibitors and various concentrations of these chemicals on the number of sprouts of stored yam tubers are presented on Table 1. The results revealed that there were no significant differences ($p \leq 0.05$) among all the chemicals used for the study, however, significant differences ($p \leq .0.05$) were observed at 6th months of storage (MOS) among the chemicals with tubers treated with extracts of neem leaves recording the least value of 1.67 when compared with the value of the control treatment.

Table 1: Effect of chemical sprout Inhibitors on the number of sprouts of stored yam tubers

Treatment sprout inhibitors	Number of sprouted stored tubers Months of storage (MOS) 1	2	3	4	5	6
GA_3	0.58	1.00	1.75	1.42	1.92	2.33
MH	0.67	1.25	1.58	1.92	2.83	2.42
NLE	0.33	1.00	1.50	1.58	1.92	1.67
CTRL	0.91	1.83	2.17	2.42	2.92	3.08
Mean	0.63	1.27	1.75	1.83	2.40	2.38
Prob. of F	0.28	0.08	0.49	0.11	0.06	0.05
LSD (0.05)	0.65	0.69	1.08	0.85	0.91	0.94

Key: GA_3= Gibberellic Acid, MH= Maleic Hydrazide, NLE= Neem Leaf Extracts, CTRL= Control

Effects of chemical sprout inhibitors on the vine length of stored yam tubers

The results of the effects of chemical sprout inhibitors on the vine length are presented in Table 2. The means of GA_3, MH, and NLE were not statistically different ($p \leq 0.05$) except at the 4th MOS where highly significant differences were observed among the sprout inhibitors. The least value was recorded in tubers treated with GA_3 (34.90) followed by tubers treated with NLE (42.62) while tubers treated with MH and CTRL had values of 76.0 and 63.1, respectively.

Table 2: Effect of chemical sprout inhibitors on vine length (cm) of stored yam tubers

Treatment sprout inhibitors	Vine Length (cm) of stored yam tubers Month of Storage (MOS) 1	2	3	4	5	6
GA_3	12.51	19.04	27.72	34.90	36.92	26.14
MH	13.34	39.65	42.91	63.14	52.10	34.31
NLE	13.07	23.64	29.33	42.62	46.74	30.75
CTRL	16.65	40.26	44.53	76.02	58.44	45.54
Mean	13.90	30.62	36.11	54.10	48.50	34.13
Prob. of F	0.95	0.12	0.66	0.01	0.39	0.41
LSD (0.05)	20.44	21.96	40.73	18.88	28.82	26.92

Key: GA_3= Gibberellic Acid, MH= Maleic Hydrazide, NLE= Neem Leaf Extracts, CTRL= Control

Effects of chemical sprout inhibitors on the vine weight (g) of stored yam tubers

The result of effect of chemical sprout inhibitors on the vine weight is presented in Table 3. The result shows that there were no significant differences ($p \leq 0.05$) among the chemicals used to inhibit sprouting for the period of the study, however, GA_3 proved superior with the least vine weight values throughout the storage period except in the 2nd month of storage where NLE had the least value (28.80) of vine weight as compared with other chemical inhibitors.

Table 3: Effect of chemical sprout inhibitors on the vine weight (g) of stored yam tubers

Treatment sprout inhibitors	Vine Weight (g) of stored yam tubers Months of storage (MOS) 1	2	3	4	5	6
GA_3	16.43	29.60	38.73	47.50	46.71	43.44
MH	21.46	36.61	49.94	69.66	72.24	50.70
NLE	19.57	28.80	42.51	58.15	60.90	47.82
CTRL	25.82	54.09	56.11	75.13	74.44	50.75
Mean	20.83	37.33	46.84	62.60	63.65	48.28
Prob. of F	0.89	0.08	0.76	0.11	0.15	0.95
LSD (0.05)	29.88	20.56	42.16	23.76	27.25	34.98

Key: GA_3= Gibberellic Acid, MH= Maleic Hydrazide, NLE= Neem Leaf Extracts, CTRL= Control

Effect of chemical sprout inhibitors on the percentage weight loss of stored yam tubers

The percentage weight loss of yam tubers increased progressively with advancement of storage period irrespective of the treatments (Table 4). The results showed that there were significant differences ($p \leq 0.05$) among the chemical sprout inhibitors in the 1st MOS with the lowest percentage weight loss obtained in tubers treated with GA_3 (2.50%), followed by tubers treated with NLE (3.22%) while the highest percentage weight loss was recorded in the control treatment (5.42%). For the rest of the storage periods however, the sprout inhibitors did not significantly ($p \leq 0.05$) affect percentage weight loss of tubers.

DISCUSSION

The postharvest behaviour of white yam *(D. rotundata*) studied in this trial is similar to that reported by other authors. Girardin *et al.* (1998) and IITA (2007) reported that GA_3 when applied to tubers soon after harvest was able to extend dormancy by 9 to 11 weeks for *Dioscorea* *rotundata* The least mean number of sprouts of stored yam tubers recorded in NLE followed by GA_3 treatments

Table 4: Effect of chemical sprout inhibitors on the percentage weight loss of stored yam tubers

Treatment	Percentage weight loss of stored yam tubers					
Sprout	Month of Storage (MOS)					
inhibitors	1	2	3	4	5	6
GA_3	2.50	10.69	16.07	21.27	25.38	32.42
MH	3.64	11.33	18.79	26.65	30.78	37.19
NLE	3.22	11.04	16.16	21.80	27.03	35.05
CTRL	5.42	13.13	19.40	29.31	33.75	40.72
Mean	3.70	11.55	17.61	24.76	29.23	36.35
Prob. of F	0.005	0.775	0.518	0.184	0.163	0.019
LSD (0.05)	1.205	6.147	6.558	8.975	8.342	4.441

Key: GA_3= Gibberellic Acid, MH= Maleic Hydrazide, NLE= Neem Leaf Extracts, CTRL= Control

indicated that extracts of neem leaf and GA_3 might have suppressed sprouting in the stored yam tubers. Ibrahim indicated that extracts of neem leaf and GA_3 might have suppressed sprouting in the stored yam tubers. Ibrahim *et al*. (1987) earlier reported that neem tree extracts have effects on sprouting as they were able to suppress sprouting for five months in stored yam tubers (*D. rotundata*). This sprout inhibitory effect of NLE might be attributed to the permeability of allelopathic substances (azadirachtin) to shoot tissues that inhibit cell division. Similarly, this finding also implies that GA_3 solutions contain some level of sprout inhibiting substances which made it to perform better than other chemical sprout inhibitors.

The non significant differences recorded among the means of sprout inhibitors suggest that the chemicals did not affect the vine lengths of the stored yam tubers. However, the significant variations observed among the means of the various concentrations imply that vine lengths of the stored tubers were affected by different concentrations. The differences observed in relation to sprout inhibitors and different concentration with respect to vine weight may be due to the corresponding number of sprouts and vine length recorded so far. The lower vine weight recorded in GA_3 –treated tubers could be as a result of the ability of the chemical in suppressing sprouts in stored yam tubers, hence the lower vine weight. This finding is in agreement with the earlier work of Girardin *et al.* (1997) who reported that one-third of the daily losses in weight were due to dislocation of reserves into the sprouts. Girardin *et al.* (1998) also reported a reduction in sprout weight and in weight loss with reduction in sprouts of stored yam tubers.

The non significant difference recorded in yam tubers treated with different sprout inhibitors in relation to weight loss indicated that the sprout inhibitors used have the potency of reducing weight loss. From the result, it is obvious that GA_3 has a significant effect on weight loss of stored yam tubers. This result is similar to the work of Osunde (2008) who reported GA_3 when applied to tubers soon after harvest was able to extend dormancy by 9 to 11 weeks for *Dioscorea rotundata*. NLE-treated tubers had low number of sprouts but high weight loss. The reason for the high weight loss when sprouting was low could be due to high rate of respiration and transpiration, as individual tubers have different respiration and transpiration pattern (Osunde, 2009). Even though sprouting may be low, other factors such as explained above may be responsible for the high weight loss of the NLE-treated tubers.

CONCLUSION AND RECOMMENDATIONS

Extracts of neem leaves (NLE) was able to suppress sprouting of stored yam tuber and since this study has revealed that this plant material inhibited sprout occurrence in stored yam tubers, storage of yam tubers could be made possible using the plant extracts. On the other hand, GA_3 was found to be effective in reducing vine weight and length, hence, reduced tuber weight loss, therefore suitable for yam storage. Based on the findings of this research, it could be recommended that for better storage of yam tubers, treatment of yam tubers with GA_3 and/or NLE should be adopted by yam growers and traders.

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