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Control of Sprouting of Yam (*Dioscorea rotundata*) and Sweet Potato (*Ipomoea batatas*) using African Cardamon (*Aframomum danielli*), Turmeric (*Curcuma longa*) and Clove (*Syzygium aromaticum*)

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Abstract

This study investigated the effects of the aqueous extracts of *Aframomum danielli*, Turmeric and Clove in sprouting of yam (*Dioscorea rotundata*) and sweet potato (*Ipomoea batatas*). The sliced tubers were dipped into the aqueous extracts of *A. danielli*, turmeric and Clove, each at concentrations of 5%, 10% and 15%. The tubers were allowed to stand in the solution for 5 and 10 minutes. Distilled water was used in the control samples. The yam slices were air dried after removal from the liquids, placed in paper boxes and incubated at room temperature (28.9 ± 4.0°C) and Relative Humidity of 44.6 ± 18.4 % for a period of six weeks (Bibah, 2014). Weight loss was determined by finding the difference between the initial and final weights and expressed as percentage weight loss. The results indicated that Turmeric treatments at different concentrations of 5%, 10% and 15% were more effective in reducing sprouting index at 5 minutes treatment time with values of 1.79%; 3.00% and 3.02% respectively. Clove treatment at 15%, 10% and 15% *A. danielli* treatment were more effective in controlling sprouting at 10 minutes treatment time for the yam tubers. There was no clear

distinction in the effectiveness of each of aqueous extract of *A. danielli*, Turmeric and Clove in controlling sprouting at 5 and 10 minutes treatment time for sweet potato tubers.

Keywords: Sprouting, *Aframomum danielli*, Turmeric, Clove, Yam, Sweet potato

1. Introduction

Yams (*Dioscorea spp.*) and Sweet potato (*Ipomoea batatas L.*) are important sources of calories for the people of the developing nations. While sweet potato is the seventh most important food crop grown in around 111 countries (Philpott, Gould, Markham, Lewthwaite and Ferguson, 2003); yams are major crops of the sub-Saharan Africa. Yam (*Dioscorea spp*.) is a major staple in West Africa where it is cultivated extensively (Akissoe *et al.,* 2011). Investigations into the causes of storage losses of roots and tubers have implicated such factors as respiration, sprouting, attack by rot-causing organisms, rodents and moisture loss among others as responsible (Okafor, 1996). Possibly the main contributor to post-harvest loss is termination of dormancy and initiation of sprouting (Lebot, 2009; Otoo, Nwuafo and Asante, 2010) and this is difficult to control. It is possible to remove sprouts from tubers during dormancy in storage but this can be costly in terms of labour time required.Dormancy appears to be essential for maintaining tuber quality. It has been reported that growth of sprouts increases the respiration rate of the tuber (Tschannen, 2003) and causes considerable dehydration and dry matter loss. Recent studies by Eze, Asiegbu, Mbah, Orkwor and Asiedu (2006) showed that it was possible to prolong dormancy period of yam using GA3 at a low concentration of 75 mg/L. It was also reported that the Chloro-Isoprophyl Phenyl Carbamate (CIPC) chemicals which is successfully used to suppress sprouting in stored potato has no effect in stored yam (Orhevba and Osunde, 2006). Malic hydrazide (1000 ppm) has also been reported to prolong dormancy of yam tubers of *Dioscorea alata* and *D. rotundata* (Ramanujam and Nair, 1982). The use of natural occurring materials as preservatives is a promising alternative to the use of chemicals (Howell, 1986). The potential sources of natural preservative are spices, herbs, fruits, seed, leaves, barks and roots (Pratt and Hudson, 1996). According to Babarinde, Adegoke and Akinoso (2014), the use of organic products such as spices with antioxidant and antimicrobial properties can serve as alternative control methods. Yapi, Gnangui, Dabonne and Kouame (2015) investigated the inhibitory effect of onions and garlic extract on the enzymatic browning of an edible yam (*Dioscorea cayenensis-rotundata* cv. Kponan) cultivated in Côte d'Ivoire. Ibrahim, Williams and Abiodun (1987) reported that neem tree extract treatment have favorable effect on sprouting in stored yam, as it was able to suppress sprouting for 5 months in stored yam tubers (*D. rotundata*). *Eze, Eze*, Ameh and Dansi *et al.* (2013) also studied the effectiveness of plant extracts of *Azadiracha indica, Xylopia aethiopica, Occimum gratissimum, C. alata and Zingiber officinale* in controlling post-harvest losses of yam tuber (*D. rotundata*) in storage. Also, organic plant extracts of neem seeds, onion bulb and ginger rhizome have been used in controlling storage rot and sprouting in sweet potato (Bibah, 2014). Also, *Aframomum danielli* has shown its potential as a preservative in some food system (Adegoke, Makinde, Falade and Uzo-Peters, 2003). Similarly, Turmeric and Clove are well known for their antioxidant, antimicrobial and anti-carcinogenic properties in food systems, as documented by Agbaje, Adeneye and Daramola (2009) and Vijhrendra, Shalini, Nirmala, Chetan and Kalpagam (2013). Therefore,

the objective of this study was designed to evaluate the efficacy of aqueous extracts of *Aframomum danielli, Curcumi longa* and *Syzygium aromaticum* in controlling sprouting of yam and sweet potato.

2. Materials and Methods

White Yam (*Dioscorea rotundata*) and Sweet Potato (*Ipomoea batatas*) tubers as well as Spices *Aframomum danielli*, Turmeric (*Curcuma longa*) and Clove (*Syzygium aromaticum*) were purchased at Bodija market, Ibadan, Oyo state.

Dried *Aframomum danielli* seeds and flower buds of Clove were winnowed, cleaned and milled after purchase. Also, the turmeric rhizomes were washed, drained, cut into pieces, dried and milled. Powder was then stored in air tight, light shielded container to prevent escape of volatile compound.

The method described by Adegoke, Fasoyiro and Skura (2000) was carried out in the preparation of aqueous extracts of *Aframomum danielli*, Turmeric and Clove. 5%, 10% and 15% concentration of each spice was prepared by dissolving 5g, 10g and 15g in 100ml of sterile distilled water. The suspension was kept at 4^0C for 5 days, centrifuged at 10,000rpm for 10 minutes. The supernatant was collected and stored for use.

2.1 Sprout Suppression Treatment

Mature and wholesome tubers of about 0.93kg and 0.36kg for yam and sweet potato respectively were selected for the treatment. The selected tubers were washed under running tap water and allowed to dry under ambient conditions

The clean and healthy tubers were dipped in the extracts. The tubers were dipped into the aqueous extracts of *A. danielli*, turmeric and Clove at different concentrations of 5%, 10% and 15%. The tubers were allowed to stand in the solution for 5 and 10 minutes and air dried after removal from the aqueous extracts. In the control, tubers were dipped into water. The tubers were then placed in paper boxes and incubated at room storage conditions (28.9 ± 4.0°C and 44.6 ± 18.4 % RH) for a period of six weeks (Bibah, 2014).Tuber weights were recorded every eight days using an industrial weighing scale balance. Weight loss was determined by finding the difference between the initial and final weights and expressed as percentage weight loss (Eze *et al.,* 2013). Also, Yam and Sweet potato tubers were assessed for signs of sprouting and the sprouting index calculated using the modified formula by Amoah, Teye, Abano and Tetteh (2011);

3. Results and Discussion

3.1 Effect of Aframomum danielli, Turmeric and Clove on Sprouting of Yam (D. rotundata) and Sweet Potato (Ipomoea batatas)

Yam tubers treated with aqueous extracts of Turmeric at different concentrations of 5% 10% and 15% for 5 minutes had the lowest weight loss throughout the storage period while the Control tuber had the highest weight loss(table 1). A similar result was obtained for percentage sprouting index, in which Yam tubers treated with aqueous extracts of Turmeric at

different concentrations had the lowest sprouting index while the Control tuber had the highest sprouting index, compared to even all the samples.From the result, it can be concluded that the Turmeric treatment has a significant effect on weight loss and sprouting of stored yam tubers. This agreed with the findings of Ibrahim *et al.* (1987) and Schmutterer, Ascher and Rembold (1980) that plant extracts are effective in controlling weight loss and sprouting of yam tubers. Weight loss in stored yam tubers is as a result of sprouting, respiration and transpiration (Ravi Aked and Balogopalan, 1996b). However, 5% *A. danielli*-treated tuber, Turmeric-treated tubers and Clove-treated tubers at the different concentrations had high sprouting index values but low weight loss in comparing the percentages; even though sprouting is one of the factors responsible for weight loss.

On the other hand, 10% and 15% *A. danielli*-treated tubers and the Control tuber had a high weight loss and low sprouting index. 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. Respiration and transpiration also depends on the size of the tuber (Osunde and Orhevba, 2011). Even though sprouting may be low, other factors such as explained above may be responsible for the high weight loss of the tubers.

Generally, for all the treated yam tubers (*D. rotundata*) in this experiment, the treatments used were able to suppress sprouting for a number of days and also reduced the sprout mass and the weight loss when compared to non-treated tubers. This is because bud formation and subsequent sprouting in yams indicates dormancy has been broken. Treatments that are able to prolong dormancy inhibit buds and sprouts formation on yams (Tortoe *et al.,* 2015). It is also worthy to note that many sprout suppressants work by interfering with the cell division processes that drive sprout growth (Elsadr and Waterer, 2005), and thus rendering the yam tubers non-viable. The results therefore showed that the treatments have been able to reduce the sprouting vigor of the yam tubers, while not tampering with the viability of the tubers.The results obtained for the yam tubers at 10 minutes treatment time, as also shown in Table 1 corresponded to what was obtained at 5 minutes treatment time, in that the Control yam tuber also exhibited the highest percentage weight loss and sprouting index. However, the results also showed that there was a general decrease in the percentage weight loss and sprouting index of the treated yam tubers, when compared to the 5 minutes treatment time. This is an indication that the longer the treatment time, the better the effectiveness of the treatments in controlling sprouting and weight loss of stored yam tubers. Clove treatment at 15%, *A. danielli* treatment at 5% and Turmeric treatment at 5% were more effective in controlling weight loss while Clove treatment at 15%, 10% and 15% *A. danielli* treatment were more effective in controlling sprouting at 10 minutes treatment time for the treated yam tubers.An exception to this general trend is the 5% and 15% Turmeric-treated yam tubers which had a considerable increase in the percentage weight loss and sprouting index, when compared to the 5 minutes treatment time. As a result, *A. danielli*-treated yam tubers had the lowest percentage weight loss and sprouting index. 10% Turmeric-treated yam tuber exhibited zero percent weight loss and sprouting index, and this may be attributed to the condition of the yam tuber before treatment. Although the concentration and time of treatment is important, the point of time when it is applied is a critical factor in influencing the hormones in the yam

tuber (Tortoe, Dowuona, & Dziedzoave, 2015).

Table 1. Effect of *A. danielli*, Turmeric and Clove on Weight Loss and Sprouting Index of Yam Tubers at 5 and 10 Minutes Treatment Times

SAMPLES	WEIGHT LOSS %		SPROUTING INDEX %	
	5 MINUTES	10 MINUTES	5 MINUTES	10 MINUTES
Untreated	33.00	10.00	17.50	25.00
A.danielli: 5%	6.12	3.30	7.14	4.40
10%	16.33	4.49	8.16	2.25
15%	19.00	4.44	11.00	2.22
Tymeric:5%	1.19	4.23	1.79	7.04
10%	1.19	0	3.00	0
15%	1.16	5.41	3.02	5.41
Clove: 5%	8.00	7.50	8.89	3.13
10%	13.04	6.40	14.67	2.56
15%	13.83	2.56	15.96	1.92

Similarly, the treated yam tubers except the 5% *A. danielli* and Turmeric-treated yam tubers as well as Control had high percentage weight loss and low sprouting index. Therefore, the treatments at 10 minutes were able to drastically reduce the weight loss and sprouting vigour of yam tubers, when compared to the untreated yam tuber, without affecting their viability.

Table 2. Effect of *A. danielli*, Turmeric and Clove on Weight Loss and Sprouting Index of Sweet Potato Tubers at 5 and 10 Minutes Treatment Times

SAMPLES	WEIGHT LOSS %		SPROUTING INDEX %	
	5 MINUTES	10 MINUTES	5 MINUTES	10 MINUTES
Untreated	19.30	12.50	4.39	5.68
A. danielli :5%	6.82	9.09	2.27	3.40
10%	36.17	5.00	1.06	5.00
15%	8.33	3.45	1.67	3.45
Tumeric:5%	14.29	8.33	2.38	4.17
10%	19.09	11.76	0.45	2.94
15%	3.70	5.88	0.19	1.25
Clove:5%	17.24	7.41	4.48	5.56
10%	6.06	7.41	0.10	5.56
15%	16.67	9.09	0	4.55

Results from Table 2 showed that at 5 minutes treatment time, 10% *A. danielli*-treated sweet potato tuber had the highest percentage weight loss while 5% Clove-treated sweet potato tuber had the highest percentage sprouting index compared to the Control tuber. This may reflect differences in the vigor or physiological age of the tubers (Elsadr and Waterer, 2005). The results also showed a high percentage weight loss and a corresponding low percentage sprouting index for all the sweet potato tubers. The high weight loss observed in this study can be attributed to a number of factors such as the respiration activity and the environmental condition around the tubers (Bibah, 2014). According to Van- Oirschot, Rees, Aked and Kihurani (2000), sweet potato loses about 90% of its initial weight through water loss under normal marketing conditions. 10% Clove-treated sweet potato tuber had the lowest percentage weight loss and sprouting index, while 15% Clove-treated sweet potato tuber had zero sprouting index. The reason for this could be attributed to the fact that the treatment gave a better sprout inhibition, while the percent weight loss could be due to the factors listed above. Generally, the treatments except in the case of 10% *A. danielli*-treated sweet potato tuber and 5% Clove-treated sweet potato tuber were able to reduce the sprouting vigour and weight loss of the tubers.

Similarly, Table 2 showed the percentage weight loss and sprouting index of the Sweet potato tubers at 10 minutes treatment time. The Control sweet potato tuber had the highest percentage weight loss and sprouting index. 15% *A. danielli*-treated sweet potato tuber had the lowest percentage weight loss while 15% Turmeric-treated sweet potato tuber had the lowest percentage sprouting index. All the tubers also had higher weight loss and corresponding low sprouting index, attributed to respiration rate of the tubers (Bibah, 2014). This was similar to the obtained values at 5 minutes treatment time.

Also, the mean values of the percentage weight loss suggested that the treatments were more effective at 10 minutes treatment time, while the mean values of the percentage sprouting index proved otherwise when compared to the 5 minutes treatment time. The relative efficacy of the different treatments was also variable, as none of the treatments had a consistent increase/decrease of the percentage weight loss and sprouting index at the different concentrations. However, the treatments were able to reduce weight loss and sprouting vigour of the treated sweet potato tubers. Moderate weight loss, no weevil damage and tuber decay was recorded, as compared to the Control tuber, in which tuber decay was observed. Although sweet potato tubers have very thin skin, tuber firmness was not affected by the treatment combinations, method and the storage period.

3. Conclusion

The aqueous extracts of *A. danielli*, Turmeric and Clove at the different concentrations used for treatment had significant effect in controlling sprouting of yam and sweet potato tubers. Also, the application rates of *A. danielli*, Turmeric and Clove extracts should be further investigated to identify the optimum rate of application in controlling sprouting, as further analysis is needed to determine how, when and how much of these ‘natural’ extracts should be used in efforts to control sprouting. Finally, long term studies of these treatments under more typical storage temperatures are also needed.

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