International Journal of Plant Pathology and Microbiology

E-ISSN: 2789-3073
P-ISSN: 2789-3065
IJPPM 2023; 3(2): 84-90
Received: 06-07-2023
Accepted: 13-08-2023

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Efficacy of organic plant extracts on the post-harvest shelf life of cocoyam (*Xanthosoma sagittifolium* (L.) Schott) during storage

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Abstract
Farmers in Sub-Saharan Africa suffer economic losses after harvest of more than 40% due to fungi infections of stored cocoyam corms. A storage study was carried out to evaluate the efficacy of organic plant extracts of *Aframomum melegueta* (Alligator pepper), *Piper nigrum* (Black pepper), and *Azadirachta indica* (Neem) on the Shelf Life and post-harvest quality of cocoyam. The factors were arranged in a (2×3) + 2 factorial style, laid in a Completely Randomized Design with three replications. Freshly harvested cocoyam corms were harvested and dipped in crude aqueous extracts of Alligator pepper, Black pepper, and Neem at concentrations of 10% w/v and 20% w/v for 5 minutes, stored at ambient conditions. The temperatures and relative humidity of the storage room ranged from 24.4ºC to 33.0 °C and 62% to 84% respectively. Results from the experiment showed that the shelf life of cocoyam was extended by 8 weeks (10% w/v Neem), 8 weeks (20% w/v Neem), 8 weeks (20% w/v Black pepper), 10 weeks (Mancozeb), and 10 weeks (20% w/v Alligator pepper) at the end of the storage period as compared to the control with a shelf life of 4 weeks. Alkaloids, tannins, phenols, saponins, flavonoids, cardiac glycosides terpenoids, and Phytosterols were found in the aqueous plant extracts. Extracts of Alligator pepper, Black pepper, and Neem significantly reduced the decay of corms, post-harvest weight loss, sprouting index and extended shelf life of cocoyam, thus can be used in the preservation of cocoyam in storage and also as an alternative to synthetic fungicides.

Keywords: *Xanthosoma sagittifolium*, plant extracts, shelf life, post-harvest, anti-fungi

1. Introduction

Cocoyam is a perennial monocotyledonous and herbaceous plant of the family Araceae. It is an important subsistence staple food for many cultures and millions of people in Africa, Asia, and the Pacific (Onyeka, 2014) [26]. The two most commonly cultivated species are *Colocasia esculenta* (taro) and *Xanthosoma sagittifolium* (Tannia). Cocoyam is made up of spherical corm (bloated underground storage stem), from which a few large leaves sprout (Onwueme, 1999) [25]. Cocoyam is the third most important cultivated and consumed root and tuber crop after cassava and yam in Nigeria and it is nutritionally superior to cassava and yam in terms of digestible crude protein and minerals (Ca, Mg, and P) contents (Green, 2003; Chukwu *et al*., 2008; Ezeonu *et al*., 2018) [17, 8, 16]. Cameroon, Ghana, and Nigeria account for over 60% of the global cocoyam production (Onyeka, 2014) [26]. Nutritionally, cocoyam is rich in carbohydrates (13 - 29%), proteins (1.4 - 3.0%), vitamins, and minerals.

Post-harvest losses of root and tuber crops have been a very serious problem for farmers as more than 40% of their harvest may be lost because of decay (Olurinola *et al*., 1992) [24]. Cocoyam corm decay and loss during storage in Nigeria is primarily a result of microbial action with an estimated 40-50% loss (Eze and Maduewesi, 1990) [12]. Chukwu *et al*., (2008) [8] reported about 50% economic losses after two months in post-harvest storage and about 95% after five months as a result of rots, sprouting, and other physiological changes during the storage of cocoyam.

Several methods are used to extend the shelf life and delay the deterioration of harvested cocoyam. Eze and Maduewesi (1990) [12] suggest storing harvested cocoyam in pits or heaps to reduce rots and maintain corm viability. Cornelius, (1998) [9] suggests using chemicals like thiabendazole and lime paste to check post-harvest spoilage of roots and tubers. Iwuagwu *et al.*, (2018) [18] found that plants with fungicidal properties effectively inhibit fungal growth *in-vivo* and *in-vitro*. Neem, black pepper, and alligator pepper are potential alternatives to control and prevent cocoyam decay during storage.

The study assessed the efficacy of *Azadirachta indica, Piper nigrum,* and *Aframomum* *melegueta* extracts in maintaining shelf life and controlling post-harvest deterioration of cocoyam (*Xanthosoma sagittifolium* (L.) Schott) in storage, while identifying phytochemicals present in the plant extracts.

2. Materials and Methods

2.1 Experimental Location

The storage study was conducted at Benue State University Makurdi's Biological Sciences Laboratory, located in Nigeria's North Central Zone, near the River Benue bridge on the Ogoja-Abuja highway (latitude 07°73'N and longitude 08°52'E).

2.2 Source and Preparation of Experimental Materials

Cocoyam corms of uniform sizes and maturity were harvested from National Root Crop Research Institute (NRCRI), Umudike, Abia State. Seeds of *Aframomum melegueta* (Alligator pepper) and *Piper nigrum* (Black pepper) were sourced from Wadata Market, and Azadirachta indica leaves were harvested from BSU campus.

Corms were washed under tap water and dried at room temperature (about 30 °C) to remove surface contaminants and opportunistic microbes (Bdliya and Dahiru, 2006) [6]. Fresh neem leaves were washed separately to remove surface dirt, then in sterile distilled water containing 1% sodium hypochlorite for 2 minutes and air dried for 7 days before milling. *P. nigrum* and *A. melegueta* seeds were sorted, washed, rinsed, and air-dried for 7 days before milling.

2.3 Preparation of Aqueous Plant Extracts

Seeds of *A. melegueta, P. nigrum,* and *A. indica* leaves were ground into powder using a blender. Extracts were obtained by adding 100 g and 200 g powders to 1000 ml sterile distilled water in conical flasks using the cold solvent extraction method as described by Nweke (2015) [21]. The suspensions were shaken for 2 minutes, allowed to stand for 24 hours, and filtered using a four-fold sterile muslin cloth.

2.4 Treatment of Cocoyam Corms with Aqueous Plant Extracts

The aqueous extracts were stirred thoroughly to ensure homogeneity, and healthy cocoyam corms were dipped into the aqueous extracts of the alligator pepper seed, black pepper seed, and neem for 5 minutes. The corms were air-dried after removal from the aqueous plant extracts. In the control, the cocoyam corms were dipped into distilled water. The treated cocoyam corms were kept on a clean labeled wooden shelf in storage for 3 months.

2.5 Experimental Design

A (2×3) + 2 factorial experiment was laid out in a completely randomized design (CRD) with three replications. Two extract concentrations (10% w/v and 20% w/v) and three plant aqueous extracts (Neem leaves, Alligator pepper seeds and Black pepper seeds) with two controls (No Treatment and treatment with 4 g/L of Metalaxyl 8% + Mancozeb 64% WP fungicide). The experiment comprised 8 treatment combinations. Each treatment unit contained 10 cocoyam corms which were labelled and weighed individually before treatment application. A total of 240 corms were used for the study.

2.6 Data Collection

Storage data was collected at every 4 weeks intervals

2.6.1 Environmental parameters

The storage room's temperature (°C) and relative humidity (%) were measured daily (06:00h, 14:00h, and 20:00h) and weekly (three times) during the storage period using a digital thermo-hygrometer. The data was evenly distributed throughout the period.

2.6.2 Physiological parameters

Post-harvest weight loss, percentage corm decay, sprouting index, and shelf life of cocoyam corms were evaluated during the storage period.

2.6.2.1 Post-harvest weight loss (%)

Post-harvest weight loss was obtained by weighing the cocoyam corms using an electronic weighing scale balance during the storage period. Weight loss was determined based on the difference between the initial corm weight and final corm weight and expressed as a percentage of weight loss.

$$\text{Post-Harvest Weight loss (\%)} = \frac{\text{initial weight - final weight}}{\text{initial weight}} \times 100$$

2.6.2.2 Sprouting index of cocoyam corms

Cocoyam corms were assessed for signs of sprouting and the sprouting index was calculated by the formula by Amoah *et al.*, (2011) [4];

$$\text{Sprouting index} = \frac{\text{number of sprouted cocoyam corm}}{\text{total number of cocoyam corms}} \times 100$$

2.6.2.3 Percentage corm decay

Cocoyam corms were visually evaluated for symptoms of decay (rots) at the end of each storage period based on the method prescribed by Tsegay *et al.*, (2013) [33]. Samples having any disease symptoms such as rots were counted and expressed as a percentage of the total number of decayed corms.

$$\text{Percentage corm decay} = \frac{\text{number of decaying corms}}{\text{total number of corms}} \times 100$$

2.6.2.4 Shelf life of cocoyam corms

The shelf life of the cocoyam corms was determined at the end of the experiment. The number of days taken for half of the corms to lose their marketability was taken as the shelf life of the cocoyam corms. Rot severity assessment was done based on a scale of 0 - 4 as described by Rees *et al.*, (2003) [30] with slight modification, where;

0-No rot / no decay
1-25% of rotten/damaged corms
2-50% of rotten/damaged corms
3-75% of rotten/damaged corms
4-100% of rotten/damaged corms

2.6.3 Phytochemical analysis of Plant Extracts

Phytochemical analysis was carried out on part of the pulverized plant materials to reveal the presence of secondary metabolites in them using the method of Okwu, (2005) [23].

2.7 Data Analysis

The data collected were subjected to analysis of variance (ANOVA) using SPSS statistical packet (version 21).

Treatment means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability.

3. Results

3.1 Temperature (°C) and Relative Humidity (%) of Storage Room

The average weekly temperature and relative humidity of the storage room varied with lower temperature and high humidity recorded during the morning periods as seen on figure 1 and 2. The temperature of the storage room ranged from 24.4 °C – 30.4 °C in the mornings, 27.8 °C – 33.0 °C in the afternoon, and 27.6 °C – 32.7 °C in the evenings. The relative humidity of the storage room ranged from 72% - 84% in the mornings, 64% - 76% in the afternoon, and 62% - 80% in the evenings. The storage period ranged from the 15th of May to the 7th of August, 2021.

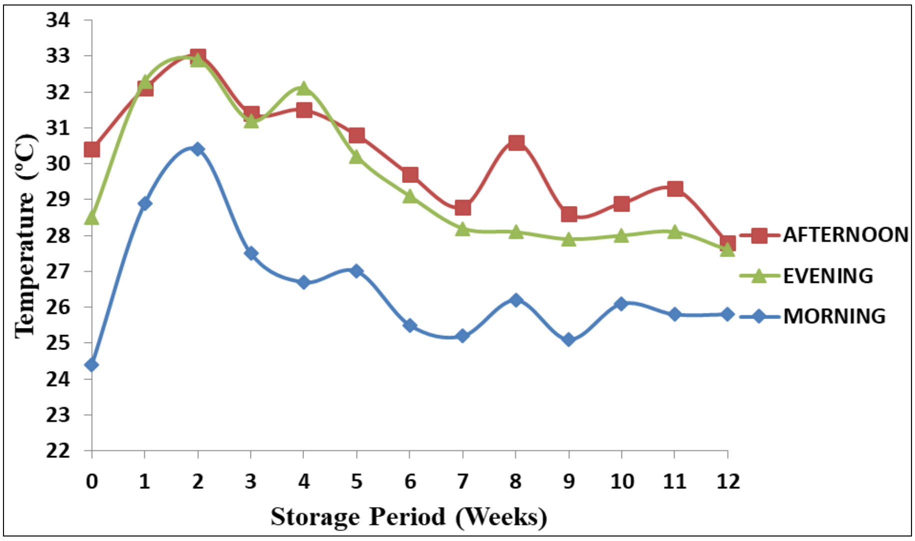

Fig 1: Weekly average maximum and minimum temperature of the storage room

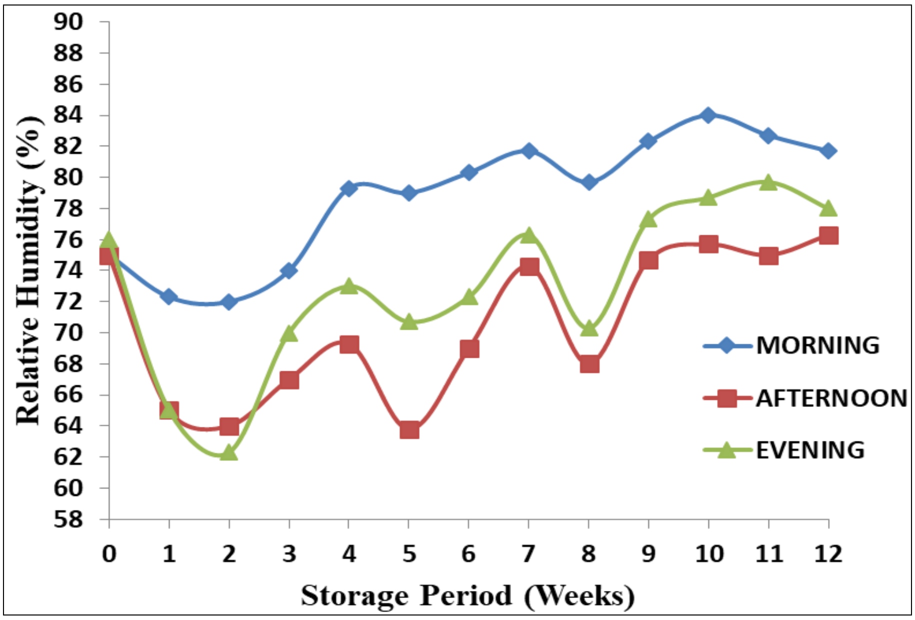

Fig 2: Weekly average maximum and minimum relative humidity of the storage room

3.2 Post-Harvest Weight Loss (PHWL) (%)

Concentration at 10% recorded a significantly higher ($p \leq 0.05$) PHWL (60.44%) than the concentration at 20% (58.17%). table 1 show that the Control (no application) had the highest mean PHWL of 65.70%. This differed significantly ($p \leq 0.05$) from Neem which recorded the lowest mean PHWL of 55.87%. The interaction effects of concentrations and plant extracts of Alligator pepper, Black pepper, and Neem on the PHWL of cocoyam corms was statistically significant ($p \leq 0.05$) throughout the storage period as shown in table 2. There was an increase in the PHWL amongst the treatment combinations as the storage period was prolonged. The treatment combination with plant extract of Black pepper (10% concentration) recorded the highest weight loss of 67.70% which was significantly higher than Neem (10% concentration) which recorded the lowest weight loss of 52.93% at 12 WAS.

3.3 Sprouting Index (%)

The result of the effect of concentration on the sprouting index of Xanthosoma corms during storage is shown in table 1 in which 20% extract concentration recorded a significantly higher ($p \leq 0.05$) sprouting index of 50.02% at the end of the storage period than 10% extract concentration which recorded 31.49% sprouting index. The sprouting index was significantly different ($p \leq 0.05$) between the plant extract means throughout the storage period. Neem extract showed the strongest sprouting potential of 44.45% at the end of the storage period as opposed to the control which showed the weakest sprouting potential of 16.67%. The interaction effect of concentrations and plant extracts of Alligator pepper, Black pepper, and Neem on the sprouting index of Xanthosoma corms was statistically significant ($p \leq 0.05$) throughout the storage period as shown in table 2. Alligator pepper (20% concentration) had the highest sprouting potential of 61.13% which was not significantly different ($p \geq 0.05$) from Black pepper (20% concentration) and Neem (10% concentration) with 50.03% and 50.00% sprouting potential respectively. This differed significantly from the control which had the lowest sprouting potential of 16.67%.

Table 1: Main effect of concentrations and plant extracts on post-harvest weight loss and sprouting index of cocoyam corms during storage

Concentration (w/v)	Post-Harvest Weight Loss (%) Sprouting Index (%)					
	4 WAS	8 WAS	12 WAS	4 WAS	8 WAS	12 WAS
10%	30.57	50.03a	60.44a	9.28a	37.09b	31.49b
20%	26.66	46.57b	58.17b	0.00b	55.57a	50.02
($p \leq 0.05$)	NS	0.029	0.043	0.001	0.001	0.001
Plant Extract						
Control	30.00ab	55.83a	65.70a	0.00b	27.77d	16.67b
Alligator Pepper	29.63ab	47.63bc	58.28bc	2.78ab	47.30bc	41.68a
Black Pepper	33.77a	52.40ab	63.75ab	5.57a	38.90cd	36.13a
Neem	25.43b	44.87c	55.87c	5.57a	52.78b	44.45a
Mancozeb	27.53ab	43.10c	58.00ab	5.57a	66.67a	38.90a
($p \leq 0.05$)	0.021	0.041	0.027	0.023	0.036	0.049

Table 2: Interaction effects of concentration and plant extracts on post-harvest weight loss and sprouting index of cocoyam corms during storage

Conc. (w/v)	Plant Extracts	Post-Harvest Weight Loss (%) Sprouting Index (%)					
		4 WAS	8 WAS	12 WAS	4 WAS	8 WAS	12 WAS
0%	Control	30.00ab	55.83a	65.70ab	0.00c	27.77c	16.67d
10%	Alligator Pepper	30.57ab	50.63ab	60.70abc	5.57b	33.47c	22.23cd
	Black Pepper	37.90a	56.68a	67.70a	11.13a	27.80c	22.23cd
	Neem	23.23b	42.80b	52.93c	11.13a	50.00b	50.00ab
20%	Alligator Pepper	28.70b	44.63b	55.87c	0.00c	61.13ab	61.13a
	Black Pepper	29.63b	48.13ab	59.80abc	0.00c	50.00b	50.03ab
	Neem	27.63b	46.93b	58.80bc	0.00c	55.57ab	38.90bc
4g/L	Mancozeb	27.53b	43.10b	58.00bc	5.57b	66.67a	38.90bc
($p \leq 0.05$)		0.045	0.011	0.049	0.001	0.001	0.001

3.4 Percentage Corm Decay (%)

Plant extract concentration of 10% recorded a higher percentage corm decay of 98.14% compared to the extract concentration of 20% which recorded a percentage corm decay of 94.43% as shown on table 3. Black pepper and control recorded the highest percentage corm decay of 100.0%. This differed significantly ($p \leq 0.05$) from Mancozeb (Fungicide) which recorded the lowest corm decay of 83.33% at the end of the storage period. The rate of corm decay increased with an increase in storage time. The treatment combination with plant extract of Alligator pepper (10% concentration), Black pepper (10% concentration), Black pepper (20% concentration), and control recorded 100.0% corm decay which was significantly higher than Alligator pepper (20% concentration) and Mancozeb which recorded 88.87% and 83.33% corm decay respectively as seen on table 6.

3.5 Shelf Life (%) of Corms

A significant difference ($p \leq 0.05$) was observed in shelf life of plant extracts, with a concentration of 20% having a longer shelf life of 8 weeks compared to 6 weeks from 10% concentration. There was a significant difference between the means of the main effect of plant extracts on the shelf life across the storage period as shown on table 3. The control had a shorter shelf life of 4 weeks, significantly lower than Alligator pepper (8 weeks), Black pepper (8 weeks), Neem (10 weeks), and Mancozeb (10 weeks). The interaction effects of concentrations and plant extracts on cocoyam corm shelf life were statistically significant ($p \leq 0.05$) throughout the storage period, as shown in table 4. The Control and 10% w/v Black pepper had the lowest shelf life of 4 weeks and 6 weeks respectively which were significantly lower than the shelf life of 10% w/v Neem (8 weeks), 20% w/v Neem (8 weeks), 20% w/v Black pepper (8 weeks), Mancozeb (10 weeks), and 20% w/v Alligator pepper (10 weeks) at the end of the storage period.

Table 3: Main effect of concentrations and plant extracts on Percentage Corm Decay and Shelf Life (%) of cocoyam corms during storage

Concentration (w/v)	Percentage Corm Decay (%) Shelf Life (%)					
	4 WAS	8 WAS	12 WAS	4 WAS	8 WAS	12 WAS
10%	31.48a	88.88a	98.14	8.35	57.87a	79.34a
20%	18.52b	81.59b	94.43	4.63	45.84b	70.38b
($p \leq 0.05$)	0.001	0.046	NS	NS	0.049	0.029
Plant Extract						

Control	61.07a	100.00a	100.00a	20.83a	81.93a	91.67a
Alligator Pepper	22.23bc	83.48bc	94.43a	5.57b	52.10b	73.20bc
Black Pepper	27.77b	94.45ab	100.00a	6.95b	58.33b	83.33ab
Neem	25.00bc	77.77c	94.43a	6.95b	45.13bc	68.05c
Mancozeb	16.67c	72.23c	83.33b	4.17b	30.53c	65.27c
($p\leq 0.05$)	0.033	0.034	0.050	0.047	0.013	0.013

NS = Not Significant

Table 4: Interaction effects of concentration and plant extracts on Percentage Corm Decay (%) and Shelf Life (%) of cocoyam corms during storage

Conc. (w/v)	Plant Extracts	Percentage Corm Decay (%) Shelf Life (%)					
		4 WAS	8 WAS	12 WAS	4 WAS	8 WAS	12 WAS
0%	Control	61.07a	100.00a	100.00a	20.83a	81.93a	91.67a
10%	Alligator Pepper	27.80bc	88.87ab	100.00a	6.97b	58.33bc	82.50abc
	Black Pepper	38.87b	100.00a	100.00a	9.73b	65.27ab	90.27ab
	Neem	27.77bc	77.77b	94.43ab	8.33b	50.00bcd	65.27d
20%	Alligator Pepper	16.67c	78.10b	88.87b	4.17b	45.87bcd	63.90d
	Black Pepper	16.67c	88.90ab	100.00a	4.17b	51.40bcd	76.40bcd
	Neem	22.23c	77.77b	94.43ab	5.57b	40.27cd	70.83cd
4g/L	Mancozeb	16.67c	72.23b	83.33b	4.17b	30.53d	65.27d
($p\leq 0.05$)		0.001	0.022	0.025	0.016	0.003	0.042

3.6 Phytochemical Analysis of Plant Extracts

Results of the qualitative phytochemical screening of Alligator pepper (*Aframomum melegueta*) Black pepper (*Piper nigrum*) and Neem (*Azadirachta indica*) are shown in table 5. The phytochemical analysis revealed that all evaluated plants tested positive for the presence of alkaloids, saponins, flavonoids, cardiac glycosides terpenoids, and Phytosterols. Tannins and phenols where present in Neem and Black pepper but absent in Alligator pepper. Alligator pepper had the least phytochemical composition while Black pepper and Neem had the highest composition of phytochemicals, testing positive for the presence of all assayed phytochemical constituents.

Table 5: Phytochemicals present in the plant extracts

Phytochemicals	Plant Extracts		
	Aframomum melegueta	*Piper nigrum*	*Azadirachta indica*
Alkaloids	++	++	++
Tannins	-	+	++
Saponins	++	++	++
Flavonoid	+	+	++
Phenols	-	+	+
Cardiac Glycosides	+	++	++
Terpenoids	+	+	+
Phytosterols	+	+	+

- = Absent
+ = Present
++ = Highly present

4. Discussions

4.1 Environmental Parameters

The temperature and relative humidity of the store varied from 24.4 °C to 33.0 °C and 62% to 84% respectively. High temperature during storage affects the rate of respiration and deterioration of cocoyam corms, as metabolic reactions increase and dry matter (carbohydrate) content decreases in roots and tuber crops, accelerating deterioration. Osunde and Orhevba, (2009) [28] found that yam tubers in barns with lower temperatures experienced 4.7% less weight loss compared to those in higher temperatures. To reduce weight loss, storage temperature should be reduced to 15-20 °C, increasing cocoyam corm shelf life (Osunde and Orhevba, 2009) [28].

High relative humidity affects fungal growth, providing a conducive environment for growth and multiplication thereby reducing dry matter content and weight of cocoyam corms during storage, affecting their commercial value. Leontopoulos *et al*., (2017) [20] reported *Fusarium solani* and *Botryodiplodia theobromae* produces spores that require high humidity for dispersal, germination, and host penetration. Rots in *X. sagittifolium* have been reported to increase with increases in humidity (Saborío *et al*., 2004) [31].

4.2 Physiological Parameters

Cocoyam corms experienced consistent increase in post-harvest weight loss across treatments during storage. Bibah (2014) [7] also observed a similar decrease in the weight of sweet potatoes in storage. Weight loss in stored root and tuber crops is as a result of sprouting, respiration, and transpiration (Ravi *et al*., 1996) [29]. Respiration and transpiration also depend on the size of the root or tuber (Osunde and Orhevba, 2011) [27]. Significantly higher PHWL was observed at 10% w/v concentration compared to 20%, with Control having the highest mean PHWL of 65.70% and Neem having the lowest at 55.87%. Osunde and Orhevba (2011) [27] similarly observed that yam treated with Neem leaf slurry had the lowest weight loss in storage. The significant high weight loss in control was due to their less resistance to moisture loss compared to cocoyam corms treated with plant extract which formed a barrier around the tubers thereby restricting the amount of moisture loss. The interaction effect between concentration and plant extract was highly significant, with Neem extract at 10% w/v having the lowest PHWL (52.93%).

Cocoyam corms began sprouting after 2 weeks of storage in some treatments. The rate increased rapidly after 4 weeks, slowing down at later stages. By the 12th week, a 20% w/v concentration had a higher sprouting index (50.02%) than a 10% concentration (31.49%). The highest sprouting index was observed in corms treated with Neem and Alligator pepper, with the control having the lowest sprouting index. This was in contrast with Adegoke and Odebade (2017) [1] who reported that yam tubers treated with plant extracts at different concentrations had the lowest sprouting index while the Control tuber had the highest. Also, Amoah *et al*., (2011) [4] reported that sweet potato roots treated with plant extracts had a low sprouting index compared to the control. 20% w/v Alligator pepper treated corms showed the highest sprouting potential compared to the control. Low sprouting index is desirable in stored cocoyam corms and low sprouting index indicates loss in vigour which subsequently shows higher percentage corm decay.

A linear rise in the percentage of corm decay occurred as the storage period extended. At the 12th week, 20% w/v concentration showed a lower decay rate (94.43%) compared to a 10% concentration (98.14%). Mancozeb, Neem, and Alligator pepper treatments had the lowest decay rates, while the Control and Black pepper treatments had the highest decay rates (100.0%) with the Control observing as incidence of 100.0% corm decay as early as 6 WAS. Alligator pepper, black pepper, and Neem extracts possess anti-fungi properties with potential to delay cocoyam rot in storage. As observed by Ezeonu *et al*., (2018) [16], Okigbo *et al.*, (2009) [22] and Amadioha and Markson (2007) [3]. Alligator pepper and Neem treated tubers have lower rotting incidences compared to Black pepper due to their higher pesticide properties. Mancozeb and 20% w/v Alligator pepper treated cocoyam corms show the least decay at the end of storage, suppressing fungi associated with cocoyam rot further.

The shelf life study shows that 20% w/v treated cocoyam corms had a longer shelf life of 10 weeks compared to 10% w/v treated corms, with a shorter shelf life of 8 weeks. Mancozeb and Neem-treated cocoyam corms had a longer shelf life of 10 weeks, compared to Alligator pepper (8 weeks), Black pepper (8 weeks), and the Control, which had a shelf life of less than 6 weeks. This could be attributed to the role the extracts had in delaying respiration, weight loss and also preventing decay of the corms during storage. An increase in cocoyam corm shelf life during storage could be aided by the presence of secondary metabolites like alkaloids, tannins, saponins, flavonoids, cardiac glycosides, terpenoids, phytosterols, and phenolic compounds which are known to have antimicrobial effects. The plant extracts also contain active ingredients like Azadirachtin and Nimbin in Neem, Piperine, and Caryophyllene in Black pepper, Gingerol, Shagaol, and Paradol in Alligator pepper which is known to have antimicrobial effects. Eze *et al*., (2013) [14] reported that the shelf life of yam was extended when treated with plant extracts of Neem and *Casia alata*. Similar results were also reported by Aghale *et al*., (2017) [2] who observed the fungicidal potency of leaf extracts of Neem, Black pepper, Bush pepper, Bitter leaf, and Basil plant in the shelf extension of yam tubers in storage. Mancozeb, Alligator pepper at 20% w/v, and Neem at 20% w/v treated cocoyam corms had the longest shelf life of 10 weeks.

4.3 Phytochemical Analysis of Plant Extracts

Aqueous plant extracts of Alligator pepper (*Aframomum melegueta*), Black pepper (*Piper nigrum*), and Neem (*Azadirachta indica*) were used in this study. Phytochemical analysis of plant extracts revealed the presence of alkaloids, tannins, phenols, saponins, flavonoids, cardiac glycosides terpenoids, and Phytosterols. The fungicidal and pharmacological potential of all these phytochemicals was proven by the report of several works (Okigbo *et al.*, 2009; Ezeonu *et al*., 2019) [22, 15]. In agreement with the findings of this study, Anukworji *et al*., (2012) [5] and Sulaiman *et al*., (2019) [32] also reported the presence of flavonoids, alkaloids, saponins, tannins, terpenoids, phytosterols, and phenols in extracts of Neem. Phytochemical screening of Black pepper by Aghale *et al*., (2017) [2] indicates the presence of alkaloids, flavonoids, saponins, tannins, and phenols in the plant extract. The phytochemical analysis of Alligator pepper by Doherty *et al*., (2010) [10] revealed the presence of tannin, saponin, flavonoid, steroid, terpenoids, cardiac glycoside, alkaloid, and phenols.

5. Conclusion

Aqueous extracts from Alligator pepper, Black pepper, and Neem show phytochemical screening for anti-microbial potency and disease control, reducing pathological decay and increasing cocoyam shelf life in storage. Plant extracts retained cocoyam's physiological properties better than the control, except for sprouting index. They were as effective as synthetic fungicide (Mancozeb) and even better in some cases, suggesting natural antimicrobial active ingredients in the extracts. Neem extract is the most effective of the three plant extracts, according to matrix of performance characteristics. Plant extracts offer a safe and affordable alternative to synthetic fungicides in IPM systems, boosting nutritional value without negatively impacting cocoyam corm composition. These botanicals are available, accessible, and affordable for sustainable organic post-harvest management.

6. References

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