Original Research Paper

Effect of three ash-based storage media on the physical quality characteristics and shelf life of three cultivars of tomato (*Lycopersicon esculentum*, Mill) grown in the greenhouse

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ABSTRACT

The study was conducted at the Department of Horticulture, KNUST to determine the effect of three ash-based storage media on the physical quality characteristics of Nemoneta, Lebombo and Pomodoro Principe tomato fruits harvested in the Greenhouse at the Department of Horticulture, KNUST. A Completely Randomized Design in factorial design was used with three replications. Fruit firmness, pericarp thickness, moisture content, postharvest fruit decay and shelf life were evaluated. Storage of the three tomato cultivars using plantain leaf ash was best in maintaining the postharvest physical quality characteristics as compared to the control, cocoa pod husk ash and coconut husk ash storage media. Nemoneta fruits stored in the different storage media averagely, ranked best among the three tomato fruits used for the physical quality characteristics evaluated. The study revealed that both Cocoa pod and Coconut husk ash storage of the tomato fruits were detrimental to postharvest fruit quality as it resulted in soft fruits texture, short shelf life, high moisture loss and high postharvest decay of tomato fruits than the Control and Plantain leaf ash storage. Based on this study, Plantain leaf ash storage was best in maintaining the physical quality characteristics thus extending[a1] shelf life.

Keywords: antioxidants, pericarp, firmness, fruit decay, senescence *and absorption*

1. INTRODUCTION

Tomato (*Lycopersicum esculentum*) is a highly perishable horticulture fruit which globally serve as a key ingredient in many dishes [1]. The global production of tomatoes stood for about 170.8 million ton in 2016 with china being the leading producer accounting for 31 Percent of the total production, India and United States followed with the second and third highest production of tomatoes in the world [5]. In Africa, Nigeria is the largest producer of tomatoes and produces up to 1.5 million tons of tomatoes [6]. Moreover, in Ghana, tomato plays a vital role in meeting domestic and nutritional food requirements, generation of income, foreign exchange earnings and creation of employment. According to [2] tomato is a cheap source of Minerals, Vitamins; Vitamin C (20 to 60mg/kg), polyphenols (10 to 50mg/kg) and some little amount of Vitamin E (5 to 20mg/kg). According to [3] as well as [4], Lycopene is a key element of Carotenoid without provitamins activity present in red tomato fruits responsible for their effect. Lycopene in a form of protein antioxidant helps in protection of cells against oxidative change and minimizes the risk of chronic diseases [3]. ~~The global production of tomatoes stood for about 170.8 million ton in 2016 with china being the leading producer accounting for 31 Percent of the total production, India and United States followed~~

~~with the second and third highest production of tomatoes in the world [5]. In Africa, Nigeria is the largest producer of tomatoes and produces up to 1.5 million tons of tomatoes [6]. Moreover, in Ghana, tomato plays a vital role in meeting domestic and nutritional food requirements, generation of income, foreign exchange earnings and creation of employment.~~

Despite the numerous benefits of tomatoes, high perishability of the fruit is a major problem leading to huge postharvest losses in many parts of Ghana, as compared to cereals. Available statistics indicates that out of 510,000 metric tons of tomato fruits produced in Ghana annually, the country losses about 153,000 metric tons (30%) of tomato fruits [7]. In addition, poor postharvest practices coupled with poor storage facilities account for the recurrent seasonal postharvest losses of tomatoes [8]. Moreover, importation of fresh and canned tomatoes into the country reduces the foreign exchange earnings [6]. [9] reported twenty percent (20%) of postharvest losses of tomatoes and lettuce just 5days after harvest.

However, storage, processing and preservation techniques are practically non-existent or very expensive beyond the means of the small-scale farmers in developing countries like Ghana and thus allows for considerable loss in produce after harvest and its vital to develop technologies and measures to prevent or minimize postharvest losses [10]. Hence screening ash, a waste product can be an easily accessible tool for a small-scale farmer to preserve harvested tomato fruits thus reducing losses and extending shelf life of harvested tomato fruits.[a2] This study seeks to develop tools accessing to small scale farmers to minimize postharvest losses of tomato fruits.

2.0 MATERIAL AND METHODS

2.1 EXPERIMENTAL SITE

The experiment was carried out in the Laboratory of the Department of Horticulture, Kwame Nkrumah University of Science and Technology, Kumasi.

2.2 SOURCES OF MATERIALS USED FOR THE EXPERIMENT

Three cultivars of tomato fruits (matured green) were obtained from the Green House at the Department of Horticulture, KNUST. The three cultivars of tomato (Lebombo, Nemoneta and Pomodoro Principe) harvested were sorted based on absent of defects, uniformity of size and red colour. Three different ashes used in the experiments were from Coconut husks, Cocoa pod husks and dried Plantain leaves. The dried Plantain leaves were collected from Madam Kate’s farm at Ayeduase Newsite, Kumasi, Ghana. Cocoa pod husks from Madam Grace Cocoa farm at Kwanwoma and Coconut husks from Coconut seller at Asafo market. ~~Small paper carton boxes were gathered for the experiments.~~

2.3 EXPERIMENTAL PROCEDURES AND DATA COLLECTION

The experimental design used was a completely randomised block design with 16treatments arranged in a (3×4) factorial scheme. Each treatment was replicated three (3) times. The Cocoa pod and Coconut husks collected were sun dried for four (4) weeks and burned in a Coal-pot as well as the dried Plantain leaves to obtain the various ashes. The different ash media used in the experiment were thinly spread evenly at the bottom of the paper carton boxes. The matured green harvested tomato fruits were arranged seven (7) in each paper carton boxes with stem end facing downward according to cultivars. The various ashes were poured on top accordingly. The Paper carton boxes containing the tomato fruits and ashes were covered and stored in cool and dry temperature at the Department of Horticulture Laboratory. Calcium, Potassium, Sodium, Phosphorus, Magnesium, Zinc and pH of the storage media were determined using the procedures of [11]. Temperature and relative humidity were determined on daily bases using data logger. Moisture content, pericarp thickness and fruit firmness were determined using the standards stipulated in [12]. Daily observation was made for the harvested fruits for the six (6) weeks storage period for any postharvest decay among the three cultivars used. Postharvest decay was determined as total number of fruits decay divided by total fruits stored and expressed as percentage [13]. Fruit shelf life was determined by [14] method.

2.4 STATISTICAL ANALYSIS

All data collected was subjected to analysis of variance (ANOVA) using Statistix version 10. Tukey's Honest Significant differences (HSD) at (1%) was used to separate treatment means.

3.0 RESULTS

3.1 TEMPERATURE AND RELATIVE HUMIDITY MEASURED DURING STORAGE

The average temperature and relative humidity recorded for the storage environment (Department of Horticulture Laboratory (KNUST) during storage of the three cultivars of tomato fruits with the various storage media for 6weeks was 27.34℃ and 74.85% relative humidity respectively**.**

Table 1. Mean average temperature and relative humidity of the storage environment

Weeks	temperature (℃)	relative humidity (%)
1	28.06	75.27
2	27.80	76.80
3	27.67	77.10
4	27.56	72.76
5	26.81	75.40
6	26.11	71.76
Means	**27.34**	**74.85**

3.2 MINERAL COMPOSITIONS OF PLANTAIN LEAF ASH, COCOA AND COCONUT HUSK ASH

Table 2: shows some mineral and pH analyses of the three types of ash used in this research. Plantain leaf ash (11.92%) had significant Calcium constituents whilst Coconut ask ash (2.39%) had the least. Cocoa pod husk ash (8.37%) had the highest Potassium

constituents and was significantly different from Coconut husk ash (7.81%) and Plantain leaf ash (3.52%). Coconut husk ash (1.48%) had the highest Phosphorus content than Cocoa pod husk ash (1.35%) and Plantain leaf ash (0.35%). Plantain leaf ash and Cocoa pod husk ash recorded the highest Magnesium contents of (2.14%) and Coconut husk ash (1.92%) with the least Magnesium content. Coconut husk ash contained the highest Sodium content of (0.42%). Plantain leaf ash (2.15mg/kg) had the highest significant Zinc content. Regarding pH, Cocoa pod husk ash (12.28) was not significantly different (p>0.01) from Plantain leaf ash (12.40) and Coconut husk ash (11.70).

Table 2: Mineral Compositions of Plantain leaf ash, Cocoa pod and Coconut husk ash

Ash	Calcium (%)	Potassium (%)	Phosphorus (%)	Magnesium (%)	Sodium (%)	Zinc mg/kg	pH
Plantain leaf	11.92a	3.52c	0.35c	2.14b	0.18b	2.15a	12.4a
Cocoa pod husk	4.40b	8.37a	1.36b	2.14b	0.10c	0.50b	12.28ab
Coconut husk	2.39c	7.81c	1.48a	1.92c	0.42a	0.23c	11.70b
LSD (0.01)	0.07	0.03	5.24	0.03	7.75	0.18	0.6[a3]

Means with the same letters do not differ significantly from each other at (p<0.01)

Fruit firmness[a4]

There were significant (p≤0.01) variety and ash interaction for fruit firmness (Table 3). Nemoneta fruits stored in plantain leaf ash (44.50N) was significantly firmer than all the varieties stored in Cocoa pod husk ash, Coconut husk ash and the Control. The less firm fruits were produced by Pomodoro Principe in Cocoa pod husk ash (17.00N), Coconut husk ash (15.33N) and the control (16.00N), which was similar to Lebombo fruit stored in Coconut husk (15.33N). Among the ash, the firmest fruits were recorded by plantain leaf ash media (39.94N) and the less firm was Coconut husk ash (22.00N). Across the variety, Nemoneta and Lebombo fruits had the firmest fruits and the lesser firmer fruits was Pomodoro Principe.

Table 3: Effect of the storage media and the three cultivars of tomato fruits on fruit firmness

	Fruit Firmness (N)			
Ash	Cultivars: Lebombo	Nemoneta	Pomodoro Principe	Mean
Plantain Leaf	44.50ab	47.50a	27.83e	39.94a
Cocoa Pod Husk	35.17cd	32.50de	17.00f	28.22b
Coconut Husk.	20.50f	30.17de	15.33f	22.00c
Control	39.50bc	32.00de	16.00f	29.44b
Mean	34.92a	35.75a	19.04b	
HSD = 0.01	Ash= 3.07	Cultivars= 2.46		Ash*Cultivars=6.65

Means with the same letters do not differ significantly from each other at (P< 0.01)

Pericarp thickness [a5]

There were significant differences (p≤0.01) observed among all the tomato cultivars stored in the storage media used (Table 4). Lebombo fruits stored in Plantain leaf ash recorded the thickest pericarp (8.61mm) among the interaction than all the tomato fruits stored in the Control, Coconut husk ash and Cocoa pod husk ash. However, Pomodoro Principe fruits stored in Cocoa pod husk ash (2.27) recorded thinnest fruit pericarp. Among the ash, Plantain leaf ash storage had the thickest fruits pericarp (6.41mm) and Cocoa pod and Coconut husk ash storage had the thinnest fruits' pericarp. Among the varieties, Lebombo tomato cultivar (6.11m) recorded the highest fruits pericarp thickness than the Nemoneta (5.52mm) and Pomodoro Principe (2.85mm) cultivars.

Table 4: Effect of the storage media and three cultivars of tomato fruits on Pericarp Thickness

	Pericarp Thickness (mm)			
Ash	Cultivars: Lebombo	Nemoneta	Pomodoro Principe	Mean
Plantain Leaf	8.61a	6.89b	3.72efg	6.41a
Cocoa Pod Husk	4.09def	4.40de	2.27g	3.59c
Coconut Husk.	5.43bcd	4.69cde	2.67fg	4.27c
Control	6.31b	6.08bc	2.71fg	5.04b
Mean	6.11a	5.52b	2.85c	
HSD = 0.01	Ash= 0.70	Cultivars= 0.57		Ash*Cultivars 1.52

Means with the same letters do not differ significantly from each other at (P< 0.01)

Moisture content[a6]

There were significant (p≤0.01) variety and ash interaction for moisture content. Nemoneta fruits stored in Plantain leaf ash (85.00%) had the highest moisture content as compared to those stored in the Control, Coconut husk ash and Cocoa pod husk ash. However, Pomodoro Principe fruits stored in Coconut husk ash recorded significantly lower in moisture content (77.00%). Moreover, across the ash, Plantain leaf ash significantly recorded the highest moisture content (83.00%) and Coconut husk ash had the least moisture content (79.17%). Among the varieties, Nemoneta fruits had the highest percentage moisture content of (83.25) and Pomodoro Principe with the least percentage moisture content of (78.50) as shown in Table 5.

Table 5: Effect of the different storage media and the three cultivars of tomato fruits on moisture content.

	Moisture Content (%)			
Ash	Cultivars: Lebombo	Nemoneta	Pomodoro Principe	Mean
Plantain Leaf	84.50b	85.00a	79.50f	83.00a
Cocoa Pod Husk	78.00i	81.00d	78.50h	79.50c
Coconut Husk.	79.00g	82.50c	77.00j	79.17d
Control	79.99e	84.50b	79.00g	81.16b
Mean		80.37b	83.25a	78.50c
HSD=(0.01) Ash= 0.10 Cultivars= 0.08 Ash*Cultivars= 0.22				

Means with the same letters do not differ significantly from each other at (P< 0.01)

Postharvest decay[a7]

There was significant decline in postharvest decay among the samples for all the cultivars of tomato fruits stored (Table 6). For the interaction, Lebombo and Nemoneta tomato cultivars stored in Cocoa pod husk ash recorded the maximum postharvest deterioration of (66.67%) which was similar to Lebombo fruits (66.66%) stored in Coconut husk ask whiles Nemoneta tomato fruits stored in Plantain leaf ash (4.13%) had the minimum percentage fruits decay. With respect to the ash factor, Cocoa pod husk ash storage (64.24%) had the maximum postharvest deterioration whiles Plantain leaf ash storage recorded the minimum postharvest fruits deterioration of (4.13%). Additionally, for the varieties, the average mean of postharvest fruits decay for Lebombo tomato fruits (55.40%) were significantly higher than Pomodoro Principe fruits (47.15%) and Nemoneta tomato fruits (40.08%).

Table 6: Effect of the storage media and the three cultivars of tomato fruits on postharvest decay.

Postharvest decay (%)				
Ash	Cultivars: Lebombo	Nemoneta	Pomodoro Principe	Mean
Plantain Leaf	34.92h	4.13j	26.35i	21.80d
Cocoa Pod Husk	66.67a	66.67a	59.37c	64.24a
Coconut Husk.	66.66a	52.38e	60.01b	59.68b
Control	53.34d	37.14g	42.86f	44.45c

Mean	55.40a	40.08c	47.15b
HSD=(0.01)	Ash= 0.02	Cultivars= 0.01	Ash*Cultivars= 0.04

Means with the same letters do not differ significantly from each other at (P< 0.01)

Shelf life[a8]

The analysis of variance showed significant differences (P≤0.01) among the cultivars (Table 7). Lebombo and Nemoneta tomato fruits stored in Plantain leaf ash significantly extended the shelf life up to (42 days) and Lebombo tomato fruits stored in both Cocoa pod and Coconut husk ash shortened the shelf life to (15 days). Plantain leaf ash media storage had the longest significant shelf life (40 days) as compared to the Control (28 days), Coconut husk ash storage (18 days) and Cocoa pod husk ash storage (17 days). The longest shelf life among the three cultivars was observed in Nemoneta fruits (28 days) as compared to Lebombo and Pomodoro Principe fruits which had a similar short shelf life of (25 days).

Table 7: Effect of the different storage media and the three cultivars of tomato fruits on Shelf life

Shelf life (days)				
Ash	Cultivars: Lebombo	Nemoneta	Pomodoro Principe	Mean
Plantain Leaf	42.00a	42.00a	36.00b	40.00a
Cocoa Pod Husk	15.00g	18.00f	18.00f	17.00d
Coconut Husk.	15.00g	21.00e	18.00f	18.00c
Control	27.00d	30.00c	27.00d	28.00b
Mean	25.00b	28.00a	25.00b	
HSD = (0.01)	Ash= 0.34	Cultivars= 0.27	Ash*Cultivars= 0.72	

Means with the same letters do not differ significantly from each other at (P< 0.01)

4. DISCUSSION

Mineral Composition of the Plantain leaf ash, Cocoa pod husk ash and Coconut husk ash used

The significant differences in mineral composition among the storage media may be due to the plant species type been burnt since the characterization of wood ash depend on the type of wooden material been burnt [15], [16]. Plantain Leaf ash however had the highest Calcium content as compared to Cocoa pod husk ash and Coconut husk ash with the least Calcium Content as presented in table (1). These results were within the ranged (2.5% to 33.5%) of Calcium present in an ash as reported by [17], [18]. The highest Calcium observed in the Plantain leaf ash may have contributed to the prolong shelf life, minimized postharvest rot or decay, low water loss and firmer fruits for Plantain leaf ash storage. The Potassium content of the different storage media ranged from (3.52% to 8.37%) which were within the range (0.1% to 13%) as reported by [17], [18]. Potassium mineral is noted for its active elements and always in a hydroxide state hence water soluble [19]. The presence of high Potassium levels recorded for Cocoa pod husk ash may have led to absorption of moisture from the storage environment and the tomato cultivars stored that resulted in wet storage media, leading to pulpy fruits texture, high postharvest decay, short shelf life and high moisture loss. The Phosphorus content obtained in this study was within the ash range (0.1% to 1.4%) stated by [17], [18]. Phosphorus is known to helped amend excessive absorption of carbon dioxide as well as Zinc toxicity in tomatoes and it also help in postharvest fruit ripening [20], [21]. Magnesium elements were more in Cocoa pod husk ash than Plantain leaf ash and Coconut husk ash respectively. The Magnesium Content obtained range (1.92% to 2.41%) for all the treatments in this study. These results were within the range (0.1% to 2.5%) of Magnesium content reported by [17], [18]. According to [22], the presence of Magnesium content enhances the stabilization of the ribosomal substances, a vital element for configuration of protein synthesis as well as matrix of the nucleus. The Sodium content (0.42%) observed in the Coconut husk ash was significantly higher than Plantain leaf ash and Cocoa pod husk ash. Moreover, the Sodium obtained from all the treatments ranged (0.10% to 0.42%) which were within the range (0 to 0.54%) by findings of [17], [18]. Sodium is also a reactive alkali and an excellent additive for food preservation. However, the presence of sodium limits the solubility of oxygen and hinder cellular enzymes [23]. Zinc Content obtained in this study ranged (0.23mg/kg to 2.15mg/kg) with Plantain leaf ash having more Zinc Content as compared to Cocoa pod and Coconut husk ash. The results for Zinc obtained in this study were much lower than Zinc (35mg/kg to 1250mg/kg) by findings of [17], [18]. The high Zinc Content in Plantain leaf ash might contribute to the minimal fungi and bacterial diseases recorded for all the cultivars stored in Plantain leaf ash [24]. The pH obtained for all the treatments ranged (11.70 to 12.4). Plantain leaf ash had the highest pH as compared to Cocoa pod and Coconut husk ash respectively. The pH obtained were within the ash pH range (9 to 13.5) reported by [17], [18]. pH measured acidity or alkalinity of a substance [25].

Effect of the different Storage Media on the physical Characteristics of the three Cultivars of Tomato Fruits (Lebombo, Nemoneta, Pomodoro Principe)

Fruit firmness

Firmness serves as maturity index as well as a vital postharvest quality parameter that regulates storage potential likewise the transportation of fruits and vegetables to distant markets without deterioration. Changes in tomato fruit firmness decreases (softening) from the immature green stage to the full ripe red colour as the storage day progressed in this study. There were significant firmer fruits among all the cultivars stored in plantain leaf ash and this may be due to a decrease in metabolic rate in those tomato fruits as compared to tomato fruits stored in the Control, Coconut husk ash and Cocoa pod husk ash respectively. Again, the variation among the cultivar types stored in the various storage media could be genetic differences. This agrees with research done by [26] who reported a difference in firmness among individual types of cultivar as well as genetic background. The presence of high Calcium content of the Plantain leaf ash may have contributed to firmer tomato fruits than fruits stored in the Control, Cocoa pod husk ash and Coconut husk ash respectively. The mechanism of Calcium firming roles results in the integration of pectin with Calcium enabling fruits and vegetables more resistant to post-handling and mechanical or physical injuries thereby promoting longer shelf-life [27], [28]. Therefore, since Calcium is the main constituent of the middle lamellae, it may have bonded the polygalacturonic acid to each other, making the membrane of the tomato fruits stored in the plantain leaf ash strong and rigid inhibiting softening [29]. According to [23], high Sodium application draw moisture and sugar ions from cells hence, the less firmer tomato fruits recorded in Coconut husk ash may be due to the presence of high Sodium levels and Potassium recorded by Coconut husk ash that may have contributed to drawing of moisture from the fruits stored leading to rapid water loss and pulpy tomato fruits texture.

Pericarp thickness

Pericarp thickness decreases from the immature green stage to the full ripe red colour as the storage days proceed and this may be due to cells losing moisture or breakdown of cell walls. According to [30], the wearing of the primary cell wall and the middle lamella leads to fruits softening particularly during fruits ripening. However, there was a general increase in thickness of pericarp for all the cultivars kept in Plantain leaf ash given the same storage media. The highest pericarp thickness observed among the cultivars stored in the plantain leaf ash may be due to the presence of high levels of Calcium content that might have increase cell formations as well as other minerals that help in cell protein and starch build up hence increase in pericarp thickness of tomato fruits stored in plantain leaf ash than fruits kept in Cocoa pod and Coconut husk ash and the Control. According to [31], about (60%) Calcium is situated in the cell wall that influence texture and firmness. Additionally, findings by [19] stated that, Potassium found in ash is always in its hydroxide state hence water soluble and minimized Calcium availability therefore the thinnest pericarp recorded by fruits stored in Cocoa pod husk ash may be due to the presence of high Potassium contents that may have contributed to drawing of moisture from cells that might affected fruit size soft and texture. Significant variations ($p<0.01$) were also observed among the tomato cultivars stored and this variation may be attributed to varietal differences.

Moisture content

Moisture content affect postharvest quality therefore a decrease in moisture will also result in poor quality fruits [32]. The moisture content decreases from the green stage to the full red ripe stage as the storage days increases. However, there were significant differences observed in moisture content of the fruits stored. Tomato fruits stored in Plantain leaf ash had the highest moisture content than the Control, Cocoa pod husk ash and Coconut husk ash. The high percentage moisture content of Lebombo, Nemoneta and Pomodoro Principe fruits stored in Plantain leaf ash, may be due to the presence of high Calcium content of the Plantain leaf ash that may have contributed to firmer fruits and thick fruit pericarp since pericarp thickness and epicutilar tissues helps in prevention of water loss from fruits hence firmer tomato fruits [33]. Genetic variation may have caused the high significant variation among the cultivars of tomato fruits stored [32]. The lowest moisture content exhibited by Coconut husk ash storage than the various cultivars may be due to the presence of high Sodium levels recorded by the storage media that might have contributed to absorption of moisture from the tomato fruits stored that led to rapid weight loss.

Postharvest fruit decay

There was a general decline in fruits decay among the tomato cultivars stored in the various storage media as the storage days proceed in this study. Moreover, tomato fruits stored in Cocoa pod husk ash recorded the highest tomato fruit decay as compared to Coconut husk ash the Control and Plantain leaf ash storage. The highest postharvest fruits decay recorded by Cocoa pod husk storage may be due to high water condensation of the storage media because of its high Potassium elements that might absorbed moisture from the fruits and the storage environment that enhanced the Proliferation of microorganisms such as; Colletotricum spp, Aspergillus niger, Aspergillus flavus, Fusarium oxysporium and Penicellium spp to cause decay. According [34], high relative humidity and water condensation within storage area influences the growth of decay causing organism. The low Percentage fruit decay or the delay in fruit rot recorded by Plantain leaf ash storage may be due to firmer fruits and thick pericarp fruit thickness recorded by these fruits because of high Calcium levels in the storage media. The mechanism of Calcium firming roles may have resulted in the integration of pectin with Calcium enabling the fruits more resistant to post-handling and mechanical or physical injuries thereby promoting longer shelf-life [27], [28]. [35] stated that, the physiological characteristics and skin barrier enables produce inhibits more microorganism's attacks since thick-wall, sub-epidermal cell and the cuticle are the constituent of the skin that serve as impermeable layer for microorganism.

Shelf life

There were significant differences observed among the tomato cultivars for shelf life. The genetic makeup of the individual cultivars might have explained the variation in shelf life among the tomato cultivars stored [32]. However, Plantain leaf ash storage (40 days) extended the shelf of Lebombo, Nemoneta and Pomodoro Principe fruits stored than the Control (28 days), Coconut husk ash (18 days) and Cocoa pod husk ash (17 days). According to [36], [37] Calcium inhibit senescence of fruits, reduction in respiration, prevention of fruit ripening, promote firmer fruits and physiological disorders. This might have accounted for the prolong shelf life recorded by Plantain leaf ash storage media since it had the highest Calcium content. [24] also stated that, the presence of Zinc in enzyme composition affect the carbohydrate metabolisms and assist tomato plant resistant to fungi and bacterial diseases, unfavorable conditions such as hot and dry environments. This may have implied that the prolong shelf life of fruits recorded by Plantain leaf ash storage may also be due to the presence of high Zinc content of the Plantain leaf ash that protected the tomato fruits from the dry environment of Plantain leaf ash. The use of Cocoa pod husk ash storage shortens the shelf life of the tomato cultivars and this may be due to water condensation of the storage media influenced by microorganisms that may have accounted to the maximum postharvest deterioration and quality loss as a result of the presence of high Potassium elements.

4. CONCLUSION

Plantain leaf ash storage was better in maintaining the postharvest quality attributes such as; fruit firmness, pericarp thickness, moisture content, postharvest decay and Shelf life of the three (3) cultivars of tomato fruits stored as compared to the Control, Cocoa pod husk ash and Coconut husk ash storage as revealed in this study. It could be revealed from this study that; Plantain leaf ash storage was best in maintaining postharvest quality characteristics however, both Cocoa pod husk ash and Coconut husk ash storage could be detrimental to tomato fruits quality as they resulted in soft fruit texture, short Shelf life, high moisture loss and high postharvest fruits decay respectively.

COMPETING INTERESTS

If no such declaration has been made by the authors, SDI reserves to assume and write this sentence: "Authors have declared that no competing interests exist.".

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