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TREATMENT OF TOMATO (*SOLANUM LYCOPERSICUM* L.) FRUITS WITH POWDERS AND ASHES FROM *TRIDAX PROCUMBENS* AND *CHROMOLAENA ODORATA* FOR SHELF-LIFE EXTENSION

Efunwoye O. O.[1], Aborisade A. T.[2], and Oladele O. O.[3]

[1]Department of General Studies, Federal College of Agriculture, Akure, Ondo State.
Email: majorbode@yahoo.com/efunwoyeolabode@gmail.com

[2,3]Department of Biology, Federal University of Technology, Akure, Ondo State.

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ABSTRACT: *Ripe and wholesome tomato fruits of Padma 108 F1 and Platinum 701 F1 were stored in powders and ashes of Tridax procumbens and Chromolaena odorata by complete submergence and surface coating treatments in a completely randomised set-up. Fruits were kept in corrugated cardboard boxes at 26.5 ^{0}C and RH 83 %. Disease incidence was assessed every 5 days in storage. The days taken for 50 % of the tomato fruits to retain marketable qualities were determined. All tomato fruits treated with the plant materials showed significantly lower disease incidences ($p \leq 0.05$) than the untreated fruits. Submerging Padma fruits in ash of C. odorata produced a shelf-life of 106 days while for Platinum fruits, submerging in powder of T. procumbens produced the longest shelf-life of 155 days. Untreated fruits of Padma and Platinum had shelf lives of 31 days and 53 days respectively. Padma fruits completely submerged in the powders of T. procumbens, C. odorata and surface coated with the powder of C. odorata retained 50 % marketability at Day 61, and 50 % of Platinum tomatoes submerged in the powder of C. odorata remained marketable at Day 116. The preservative effects of the powders and ashes of the two botanicals in tomato fruits could probably be accounted for by a combination of moisture-absorbent properties, restraining airflow, high pH and the presence of phytochemicals.*

KEYWORDS: Weeds, powder, ash, tomato, postharvest.

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INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is a vegetable crop widely grown all over the world. According to Ochida *et al.* (2019), tomatoes originated in the regions of Peru, Ecuador, and other parts of tropical America. Tomato is a fleshy, edible fruit berry that belongs to the family *Solanaceae* and is extensively consumed globally. The widespread cultivation and consumption all over the world is attributable to its nutritional and economic importance. Tomatoes are consumed either raw or cooked and in various processed forms such as salads, drinks, paste, puree, ketchup and whole peeled tomatoes. Tomatoes and tomato-based foods provide a wide variety of nutrients and many health-related benefits to the body. The nutritional benefits include minerals like potassium, magnesium, calcium, iron and zinc, vitamins (A, B1, B2, C and E), dietary fibre (pectin) and citric acid (Passam *et al*., 2007; Etebu *et al*., 2013). Tomato also contains lycopene which has a high antioxidant ability against oxygen radicals that probably cause cancer, ageing and arteriosclerosis (Freeman and Reimers, 2010). Tomato (*Solanum lycopersicum*) global annual production volume is approximately 187 million tons on a cultivated area of over 5 million hectares (FAOSTAT, 2022). Nigeria was estimated to produce 4.1 million tons of tomatoes in 2021, which places her as the second largest producer of the fruit in Africa, after Egypt (FAOSTAT, 2022). Smallholder farmers are responsible for 90 % production of tomatoes in Nigeria because of their wide scale of consumption and acceptance (Osunmuyiwa *et al*., 2021). Of this total, only about 20 % are processed into other forms while about 50 % are lost in the post-harvest value chain (FAO, 2018). According to a report by Pricewaterhouse Coopers in 2018, postharvest losses of tomatoes in Nigeria have been attributed to poor storage facilities and inefficient transport systems. Tomatoes are highly perishable owing to their high moisture and nutritional contents which keep the shelf-life at about 48 hr (Babarinde *et al*., 2014). Post-harvest losses are due to respiration in the fruits after harvest, transpiration in storage and microbial attack (Babalola *et al*., 2008). The fruit is an important part of the family diet in Nigeria and with a growing population, consumption is expected to increase, thereby instigating an increase in production. The problem of inadequate post-harvest storage facilities, poor power supply and transport systems may drive up post-harvest loss volumes.

Presently, there are methods for post-harvest storage of tomatoes. Low-temperature storage treatment, heat treatment, controlled atmosphere method, modified atmosphere method, chemical treatment and coating with edible materials have all been approaches proposed for the prevention of post-harvest loss of tomatoes (Safari *et al*., 2020; Swetha and Banothu, 2018; Hosea *et al*., 2017; Sood *et al*., 2011). Low-temperature storage treatment, controlled atmosphere and modified atmosphere methods are all dependent on constant electricity supply, which is a major problem in developing countries. In addition, the technologies of low-temperature storage (refrigeration and cooling), controlled atmosphere and modified atmosphere packaging are expensive for smallholder farmers, who are the principal producers of tomatoes in rural areas (Sood *et al.*, 2011; Thiruphati *et al*., 2006)). In addition, the use of chemical agents to treat tomatoes to prevent post-harvest losses has been widely practised and found to be relatively effective (Benjamin *et al*., 2016; Gharezi *et al*., 2012). However, this method has been observed to present specific limitations and challenges. The use of synthetic chemical agents to treat horticultural crops like tomatoes has raised concerns about the health and environmental risks to consumers. Also, Babarinde *et al.* (2014), among other workers, stated that some of the spoilage pathogens have developed genetic resistance against these synthetic chemical agents, which render them less effective.

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LITERATURE

Several challenges have been documented in the preservation of tomatoes, and in efforts to mitigate these, researchers have been exploring the use of natural (organic) substances which possess antimicrobial activities against the spoilage pathogens of tomatoes to reduce post-harvest losses. Several organic substances such as plant materials and extracts from plant origins have shown the potential to extend the shelf-life of tomatoes, without posing any notable health risk to consumers. Plants and plants derivatives of *Aframomum danielli* (alligator pepper), *Thymus vulgaris* (Thyme), *Zingiber officinale* (ginger), *Azardirachta indica* (neem), oregano (*Origanum vulgare*), cinnamon (*Cinnamomum zeylanicum*), Cumin (*Cuminum cyminum*), have all been examined for potentials to extend the shelf-lives of vegetables and fruits (Hosea *et al*., 2017; Qing Lui *et al*., 2017; Tartoura *et al*., 2015; Babarinde *et al*., 2014 and Dorman and Deans, 2000). Most available reports on the use of plant materials for tomato storage are focused on extracts of parts of plants while scarce attention has been paid to other preparations of botanical origin obtainable from the whole plant in a method that is easily applicable by smallholder farmers which are mainly located in the rural areas. This study aims to assess the efficacy of *Tridax procumbens* and *Chromolaena odorata* preparations as protectants of tomato fruits against postharvest fungi. The study will investigate the potential of dried powders and ashes of whole plants of *Tridax procumbens* and *Chromolaena odorata* in influencing the shelf-life of tomatoes.

METHODOLOGY

Source of planting materials

The Padma 108 F1 and Platinum 701 F1 tomato varieties seeds were obtained from an agro-based materials store. They were cultivated in an experimental field at the Federal College of Agriculture, Akure, Ondo State, Nigeria between January and May 2023.

Fruits preparation

Wholesome, ripe and sound fruits were harvested manually, without bruising or damage. Tomato fruits of the same size and ripeness were selected for this study to ensure uniformity in all factors in the experiment. The selected tomato fruits were washed in potable water to remove dirt and dipped in 2.0 % sodium hypochlorite solution for 10 mins to surface sterilize.

Plants materials preparation

Whole plants of *Tridax procumbens* and *Chromolaena odorata* were harvested from fields and authenticated in the Federal College of Agriculture, Akure. The plant materials were washed in clean water and sundried for 30 days.

The dry plant materials were pulverized using mortar with pestle into fine powder which was sieved with fibre of 0.5 mm mesh size. The fine powder was collected, labelled and preserved in clean, dry cellophane bags. For ash preparations, dry plant materials were burnt into ashes in a clean metal drum with an unpainted inner surface. The ash was sieved with a 0.5 mm mesh size, collected in clean, dry cellophane bags, labelled and preserved in a cool, dry cupboard until use.

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Fruits Treatments

The surface-disinfected fruits of each variety were subjected to two forms of treatments in a completely randomized design using the plant preparations. The set-up involved fifteen (15) fruits of tomato per lot. Lots 1-4 were fruits surface coated with and completely submerged in powders (240 g) of *Tridax procumbens* and *Chromolaena odorata* respectively. Further, lots 5-8 contained fruit surfaces coated with, and submerged in 240 g ashes of *T. procumbens* and *C. odorata* respectively, while the control (untreated fruits) occupied lot 9. The control treatment was prepared by dipping the fruits in sterile distilled water for 10 minutes. All the fruits were carefully arranged inside corrugated cardboard boxes of size 340 × 205 × 240 mm, with the inside lined with cellophane papers that were surface sterilized with methylated spirit. All the boxes were arranged on the workbench in the laboratory according to the lot number. The room temperature was monitored using an HTC-2 digital thermometer for the period of observation, and the fruits were observed for disease incidence and marketability at five days intervals until all fruits were completely diseased for each treatment. Marketability attributes of the fruits were assessed visually for characteristics that include the absence of lesions, microbial growth and absence of shrivelling. The smoothness and glossiness of fruits were also noted. All experiments were set up in triplicates.

Fruit disease incidence was determined as below (Getachew *et al.*, 2014; Fashanu *et al.*, 2019);

$$\text{Disease Incidence (\%)} = \frac{\text{number of diseased fruits}}{\text{Total number of fruits}} \times 100$$

The marketability of fruits was determined using the method of Hosea *et al*., (2017).

$$\text{Marketability (\%)} = \frac{\text{number of wholesome fruits}}{\text{Total number of tomato fruits}} \times 100$$

Statistical Analysis

Data were subjected to analyses of variance and where significant, means were separated using Duncan's New Multiple Range Test at $p<0.05$. The statistical package SPSS 20.0 was employed for analyses.

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RESULTS

The disease incidence rates in Padma 108 F1 tomato fruits treated with powder of *Tridax procumbens* are shown in Fig1.

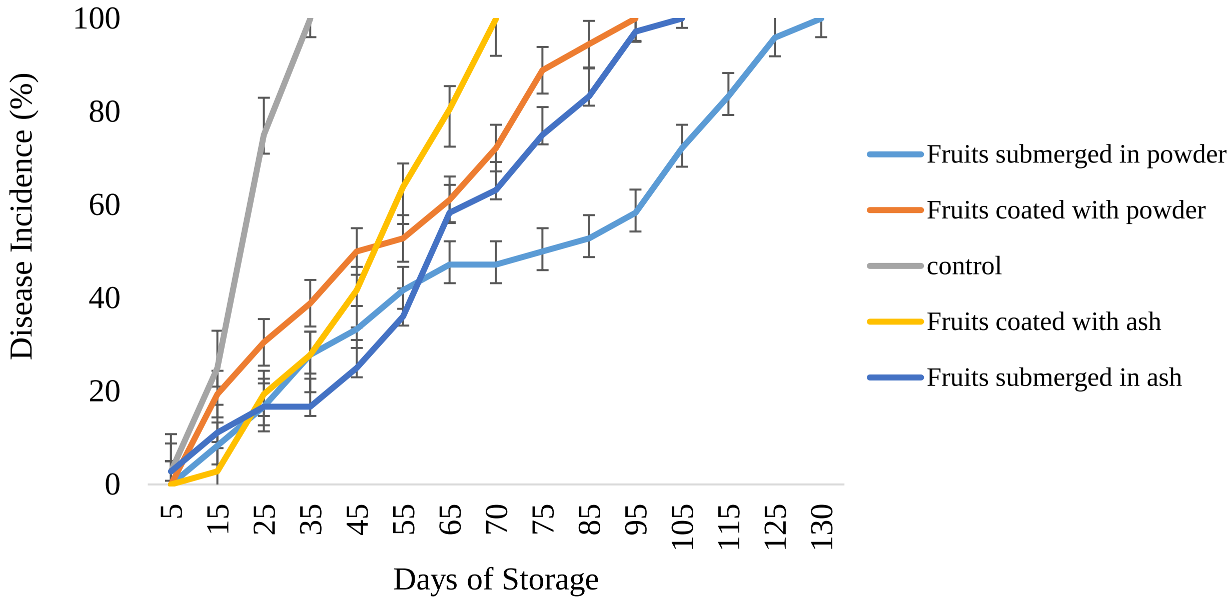

Fig. 1. Effects of treatments with *Tridax procumbens* on rate of disease incidence in Padma tomato fruits

The Padma tomato fruits submerged in the powder of *Tridax procumbens* exhibited the lowest rate of disease incidence in the period of storage, followed by the fruits submerged in ash. The highest disease incidence rate was observed in fruits in the control treatment.

The effects of treatments of Padma 108 F1 tomato fruits with *Chromoleana odorata* are shown in Fig. 2 below;

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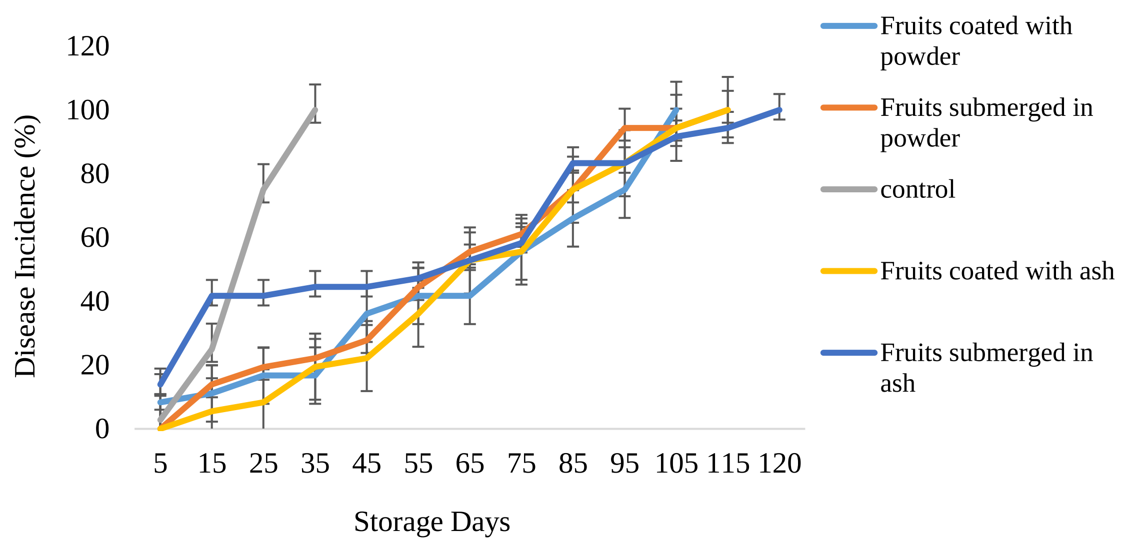

Fig. 2. Effects of treatments with *Chromolaena odorata* on disease incidence in Padma tomato fruits

The rates of disease incidence in all the treated fruits were close but the highest rate of disease incidence was observed in the control fruits.

The rates of disease incidence on Platinum 701 F1 tomato fruits are shown in Fig. 3;

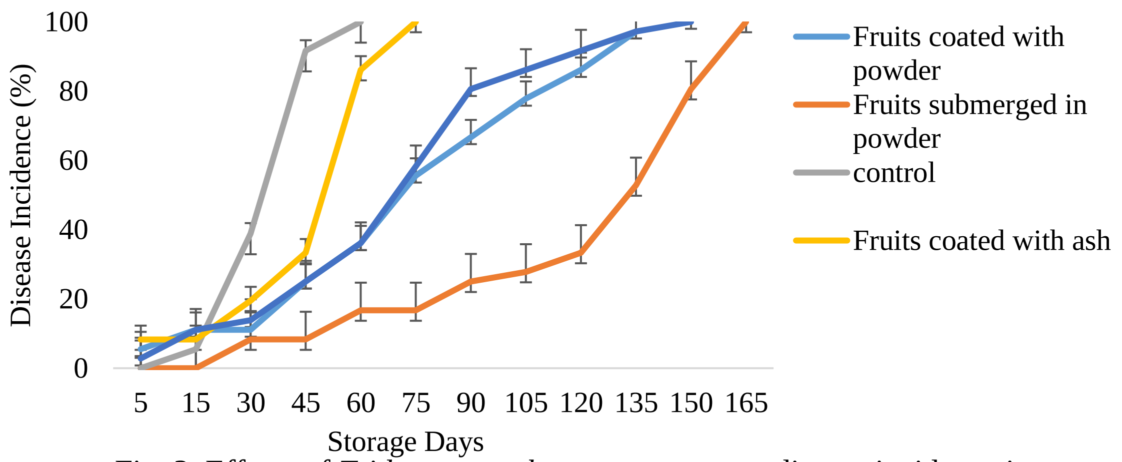

Fig. 3. Effects of *Tridax procumbens* treatments on disease incidence in Platinum tomato fruits

The lowest rate of disease incidence was observed in the Platinum tomato fruits submerged in the powder of *Tridax procumbens* weed, followed by the fruits coated with the same powder. The highest rate of disease incidence was recorded in the Platinum tomato fruits treated as the control for the experiment.

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In Fig. 4, the rates of disease incidence on Platinum 701 F1 tomato fruits are presented;

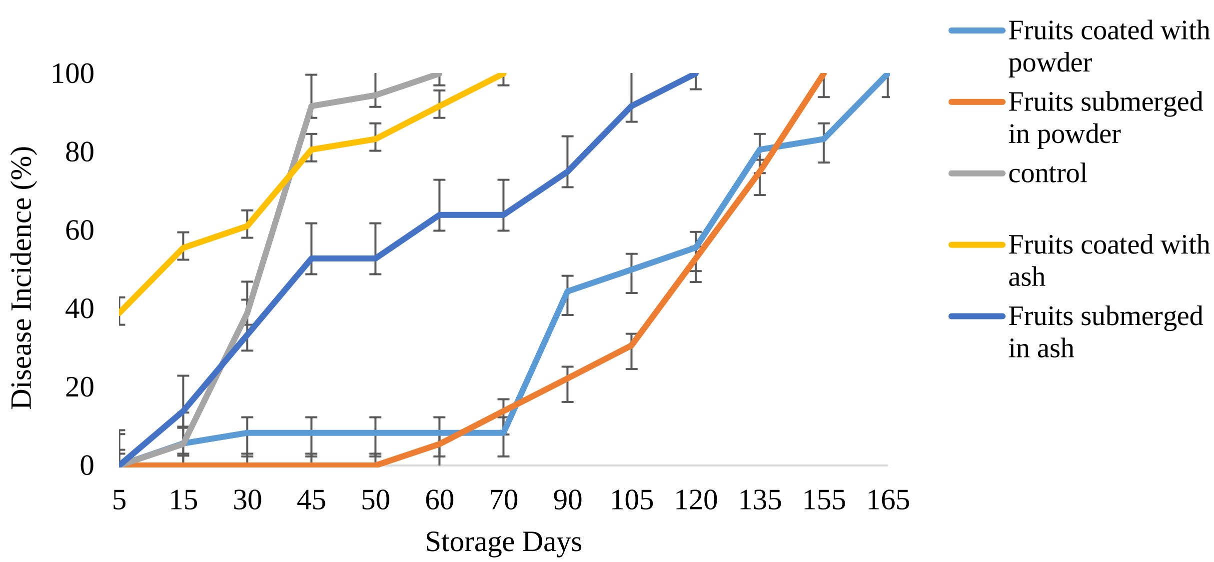

Fig. 4. Effects of treatments with *Chromolaena odorata* on disease incidence in Platinum tomato fruits

The rates of disease incidence in Platinum 701 F1 tomato fruits submerged in powder of *Chromolaena odorata* and coated with the same powder were observed to be the lowest while the fruits coated with ash and those of the control had the highest disease incidences.

Table 1: Effects of treatments with *Tridax procumbens* and *Chromolaena odorata* on shelf-lives of Platinum and Padma tomato fruits.

		SHELF-LIFE (DAYS)	
TREATMENT/ CULTIVAR		PADMA	PLATINUM
T. procumbens	Powder coating	86.6667±6.00925^{ab}	128.3333±6.00925^{ab}
	Powder submerging	96.6667± 1.66667^{a}	155.0000± 7.63763^{a}
	Ash coating	105.0000 ± 00000^{a}	133.3333±18.78238^{ab}
	Ash submerging	100.0000±7.63763^{a}	143.3333 ± 7.26483^{a}
C. odorata	Powder coating	105.0000 ± 00000^{a}	65.0000 ± 2.88675^{cd}
	Powder submerging	100.0000±7.63763^{a}	105.0000±17.55942^{bc}
	Ash coating	96.6667 ±1.66667^{a}	61.6667 ± 8.33333^{cd}
	Ash submerging	106.67 ±10.92906^{a}	110.0000 ±7.63763^{bc}
Untreated		31.6667 ± 1.66667^{c}	53.3333 ± 4.40959^{d}

Mean values and standard error with different letters within a column are significantly different according to Duncan's Multiple Range Test ($p \leq 0.05$).

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Table 2: Days taken for a minimum of 50 % of tomato fruits treated with materials of *Tridax procumbens* and *Chromolaeana odorata* to retain marketability quality.

		DAYS	
TREATMENT/ CULTIVAR		PADMA	PLATINUM
T. procumbens	Powder coating	45.0000 ±11.54701[ab]	70.0000 ± 2.88675[bc]
	Powder submerging	61.6667 ± 1.66667[a]	108.3333 ±1.66667[a]
	Ash coating	43.3333 ± 6.66667[ab]	53.3333 ±1.66667[cd]
	Ash submerging	60.0000 ± 11.54701[a]	76.6667 ±10.13794[b]
C. odorata	Powder coating	61.6667 ±12.01850[a]	113.3333±11.66667[a]
	Powder submerging	61.6667 ±11.66667[a]	116.6667 ±3.33333[a]
	Ash coating	66.6667 ±9.27961[a]	39.3333 ±10.92906[de]
	Ash submerging	51.6667 ±18.55921[ab]	43.3333 ±6.00925[d]
Untreated		20.0000 ± 0.00000[b]	36.6667 ±1.66667[e]

Mean values and standard error with different letters within a column are significantly different according to Duncan's Multiple Range Test ($p \leq 0.05$).

DISCUSSION

The Padma 108 F1 and Platinum 701 F1 tomato varieties exhibited spoilage in storage with visible lesions, mould growth, rot and shrivelling. Padma fruits treated with botanical preparations from *Tridax procumbens* showed varying influences on rates of disease incidence (Fig. 1). All the Padma tomato fruits treated with *Tridax procumbens* exhibited significantly lower disease incidences ($p \leq 0.0.$) than the control fruits throughout the storage period. The Padma tomato fruits submerged in the powder of *Tridax procumbens* showed the lowest rate of disease incidence (47.2 % on Day 70) followed by the fruits buried in the ash (69.4 % on Day 70). A similar trend was reported by Safari *et al.* (2020) and Brito *et al.* (2021), in which the highest rates of disease incidences were reported in untreated tomato fruits when tomato fruits were stored by coating with chitosan and vanilla, and coating with essential oils from thyme, oregano, lemon and orange respectively. Among the treatments, submerging in the powder and the ash provided the best activities in the use of *Tridax procumbens* in storing Padma tomato fruits. At the first 15 days of storage, the Padma tomato fruits coated with ash of the plant showed the least diseases at below 3 % while the control fruits already had about 25 % of the fruits diseased. By day 55, the fruits submerged in the powder had about 47.1 % diseased fruits, the ones coated with ash showed a disease incidence of 63.1 % while the control fruits already had 100 % diseased. It is evident that burying Padma tomato fruits in the powder of *Tridax procumbens* slowed down the rate of development of disease on the fruits than all other treatments. This may be a result of the fruits being completely covered, which reduces the amount of air available to the fungal pathogens of tomatoes as moulds are known to be aerobic organisms. In addition, the moisture-absorbing property of the dry plant materials probably reduced moisture inside the boxes which may not favour the growth of the fungal pathogens of tomato.

Treatment of Padma tomato fruits with materials from *Chromoleana odorata* (Fig. 2) showed that the rate of disease incidence was highest in the control fruits all through the storage days while other treatments exhibited significantly lower rates of disease incidence ($p \leq 0.05$), which

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is similar to the trend observed in the treatment with *Tridax procumbens* and also the reports of Hosea *et al.,* (2017), Bakpa *et al.,* (2018), Safari *et al*., (2020) and Brito *et al.,* (2021) where plants materials like neem leaf powder, guava leaf extracts, neem leaf extracts, bitter leaf extracts and wood ash respectively were used to store tomato fruits. The rate of disease development in the Padma tomato coated with the powder of *Chromoleana odorata* is the lowest in all the treatments throughout the storage days, though, fruits submerged in the ash showed the highest rate of disease development (47.2 %) from Day 5 to 50 when others ranged from 30. 6% to 41.7 % incidences (Fig. 2).

Fig. 3 indicated that Platinum tomato fruits submerged in the powder of *Tridax procumbens* showed the lowest rate of disease incidence while the Platinum fruits in the control set-up (untreated fruits) had the highest rate throughout the period of storage. As of Day 125 of storage, the Platinum tomato fruits submerged in the powder of this plant had a disease incidence of 33.3%. Fruits coated with the powder had a disease incidence of 86.1 %, the ones submerged in ash had an incidence of 94.4% while fruits coated with the ash had completely been diseased. Similarly, submerging Platinum tomato fruits inside the powder of *Chromolaena odorata* produced the lowest rate of disease incidence (Fig. 4). The Platinum tomato fruits coated with the ash of the plant exhibited the highest rate of disease similar in trend to the control fruits. On Day 35, both the fruits coated with ash of the plant and the control fruits had 80 % of the fruits already diseased, however, the Platinum tomato fruits submerged in the powder had zero diseased fruit, while the fruits coated with the powder had 8.3 % diseased, and 44.5 % of those submerged in ash had developed disease. The observed performance of the *Chromolaena odorata* powder on the rate of disease incidence in the Platinum tomato fruits is similar to the report of (Banjo *et al.*, 2022) in which the rate of disease development was decreased in tomato fruits coated with the dry powder of the leaves and bark of *Annona muricata*.

In this study, all the botanical preparations from both plants reduced the rates of disease incidences on both Padma and Platinum tomato fruits to varying degrees.

For the shelf-lives of Padma tomato fruits (Table 1), all the treatments with the botanical preparations of both *Tridax procumbens* and *Chromolaena odorata* showed varying days of shelf-lives with no statistical difference, but were significantly different from the control (untreated) fruits. The Padma tomato fruits submerged in the ash *of Chromolaena odorata* had the longest shelf-life of 106 days, closely followed by the tomato fruits coated with a powder of the same plant and the fruits coated with the ash of *Tridax procumbens* which both had shelf-lives of 105 days respectively. The ability of the ashes of both plants to extend the shelf-lives of this tomato variety is in agreement with the findings of Fashanu *et al*., (2019) and Lawal *et al.* (2019) who reported extension of shelf-lives of tomato fruits stored by covering with ashes of wood and wood by-products respectively. Bakpa *et al*., (2018) similarly reported the extension of shelf-lives of three varieties of tomato fruits stored with ash of plantain leaf and cocoa pod husk ash. Agbeyi (1998) and Channya (2002) stated that the alkalinity of ash (pH 8-9) may discourage the growth of moulds that cause rot on storage crops. Molds are organisms that grow optimally in low pH conditions. In addition, Prakash *et al*. (2016) submitted that ash contains silica which hinders the growth of fungal pathogens and reduces the relative humidity of the storage conditions. Therefore, the observed extended shelf-lives of the Padma tomato fruits by the ash of *C. odorata* could probably be attributed to the high pH of the ash, reduced relative humidity condition and dryness of the tomato surface caused by the ash. The least shelf-life of 31 days was observed in the control (untreated fruits).

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For the Platinum tomato fruits variety (Table 1), the fruits stored by submerging in the powder of *Tridax procumbens*, the ones submerged in the ash of the same plant, fruits coated with the ash of the same plant and the ones coated with the powder of the same plant did not show any significant difference in shelf-lives. However, the fruits submerged in the powder of *Tridax procumbens* exhibited the longest shelf-life of 155 days, followed by the fruits submerged in the ash of the same plant with a shelf-life of 143 days. This finding is similar to the discovery of Irokanulo *et al*., (2015), when tomato fruits of different cultivars were stored in the powder of leaf, stem and bark of the *Moringa oleifera* plant and the shelf-lives of the tomato fruits were all extended. All the Platinum tomato fruits stored with botanical preparations of *Chromolaena odorata* showed significant differences in shelf life. The control fruits exhibited the shortest shelf-life of 53 days, which is statistically different from the shelf lives of all the fruits treated with plant materials.

The natural shelf-life of Platinum tomato fruits was observed to be significantly longer than that of the Padma variety (Table 1). Platinum tomato fruits are small, spherical, with a thick pericarp, while Padma tomato fruits are big, ovoid with a thin pericarp. The biological structures of tomato fruit varieties, which are mostly a result of genetic differences, are observed to play important roles in their shelf lives (Hosea *et al.*, 2017; Bakpa *et al*., 2018). The thicker pericarp and smaller mass/volume ratio in the Platinum variety compared to the Padma variety, could be responsible for a slower rate of moisture loss and softening of the lamellae tissues, thereby reducing the rate of senescence (Anthon *et al*., 2005, Suslow *et al*., 2009). Moreover, all the treatments with the botanical preparations significantly improved the shelf-lives of both varieties of tomato (Table 2).

Table 2 shows that days taken for a minimum of 50 % of Padma tomato fruits treated with both plant materials to remain marketable are not significantly different, but all are significantly different from that of the control fruits with 20 days. This trend is in consonance with the reports of Hosea *et al*. (2017) and Safari *et al*. (2020), in which treatments of tomato fruits with different plant materials showed significant differences in the marketability of the treated fruits and control fruits. The longest days taken to retain 50 % of the Padma tomato fruits in marketable condition was 66 in the fruits coated with the ash of *Chromolaena odorata*, followed by 61 days in the Padma tomato fruits coated with a powder of *Chromolaena odorata*, submerged in the powder of *Chromolaena odorata* and submerged in the powder of *Tridax procumbens* respectively.

For the Platinum tomato fruits (Table 2), the number of days taken for a minimum of 50 % of all the fruits treated with the botanical materials of both plants, except the fruits submerged in the ash of *Chromolaena odorata*, to retain marketability were statistically different from the control fruits. This finding is in contrast to Kator *et al.* (2018) which reported no significant difference in the marketability of tomato fruits coated separately with the powder of neem, moringa and bitter leaf plants, across the days of storage. The fruits submerged in the ash of *Chromolaena odorata* showed the longest days (116) for reduction of marketable fruits to 50 %, followed by fruits coated with the powder of the same plant (113 days) and fruits submerged in the powder of *Tridax procumbens* (108 days) respectively, which are all not significantly different ($p \leq 0.05$). The fruits coated with the ash of *Chromolaena odorata* took 39 days for the marketable sample size to reduce to 50 %, though not significantly different from the days taken for the control fruits (30 days) to reduce to the same.

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In this study, the treatment observed to be most effective in reducing the rates of disease incidences, extending the shelf-life and preserving marketability attributes in Padma tomato fruits was by submerging the fruits inside the ash of *Chromolaena odorata*. However, the treatment discovered to be most effective in reducing the rates of disease incidence, extending the shelf-life and preserving marketability characteristics of Platinum tomato fruits was by submerging the fruits inside the powder of *Tridax procumbens* and submerging inside the powder of *Chromolaena odorata*.

The treatment of tomato fruits with plant materials has been reported to extend the shelf-lives of the fruits significantly, according to Ahmed *et al*. (2016), Babarinde *et al*. (2014), Hosea *et al*. (2017), Kator *et al*. (2018) and Banjo *et al*., (2022). Plants produce phytochemicals as secondary metabolites that are known to have antimicrobial activities against pathogens of tomato and other plants. The phytochemicals include alkaloids, tannins, saponins, and flavonoids (Liamngee *et al.* 2019). According to Sarkar *et al*. (2016), Maldhure *et al*. (2017), and Acharya and Srivastava (2020), extracts of *Tridax procumbens* plants possess alkaloids, flavonoids, glycosides, terpenoids, tannins, protein and steroids, which are all active against plant pathogens such as *Bipolaris sorokiniana*, *Aspergillus flavus, Rhizoctonia solani* and *Rhizopus stolonifer.* Chiejina and Onaebi (2016) stated that *Chromolaena odorata* extracts possess alkaloids, phenols, tannins, saponins and flavonoids with antimicrobial activities against *Geotrichum candidum*. The presence of these phytochemicals in the weeds employed in the treatments of tomatoes in this study may have contributed to the observed reduction in disease incidences which might have brought about the extension of the shelf-lives, and preserved marketability attributes in both varieties of tomato. In addition, the dry conditions of the botanical preparations and higher pH in the ashes are factors that probably influenced these significantly improved storage quality parameters.

IMPLICATION TO RESEARCH AND PRACTICE

The findings of this study will contribute greatly to the available knowledge base for the use of botanical materials in the storage of horticultural crops generally, especially tomatoes. The findings provide insight into the activities of powders and ashes obtained from whole plants of T. procumbens and C. odorata in reducing the rate of disease development in stored ripe tomatoes and the extension of the shelf-life of the fruits while detailing the effects on the marketability quality parameters of tomato. The wide abundance, availability of and accessibility to the plants in Nigeria, and ease of preparing and handling these botanical preparations in tomato storage for smallholder farmers, middlemen and retailers in the tomato value chain makes the study of significant economic importance as its practice has the potential to reduce economic loss attributable to storage fungal spoilage of tomatoes. The prolonged shelf-life of tomatoes will bring about off-season availability of the fruits. The risk posed to humans and the environment by the indiscriminate use of synthetic/chemical preservatives on tomatoes will be hugely mitigated by the use of these plant materials.

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CONCLUSION

All the botanical preparations of both plants employed in this study significantly reduced the rates of disease incidences, extension of shelf-lives and preservation of marketability attributes of both Padma and Platinum tomato fruits. The use of these botanical preparations from these two plants exhibited an extension of shelf-lives in both varieties of tomato by greater than 100 %. Employing botanical preparations from plants will provide a cheaper, safer and more environmentally friendly alternative to the common practice of using chemical means to preserve tomato fruits. The mode of preparation of these botanical materials is simple and easily reproducible by smallholder farmers and tomato sellers in rural areas. The findings in this study further improve available information on the potential of botanical materials for the storage of tomatoes which strengthens the present campaign for the reduction in or discontinued use of chemical preservatives for the storage of tomatoes.

FUTURE RESEARCH

This study did not include an investigation into the specific phytochemicals and bioactive agents present in the botanical preparations. Further research on the effect of these botanical preparations on specific storage pathogens and their mode of action on microorganisms could explain the action of the bioactive agents present in the botanical preparations from the two weeds.

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