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ORIGINAL ARTICLE

Antimicrobial activity of *Chrysophyllum albidum* seed extract and its effect on the physicochemical properties of cherry tomato fruits during postharvest storage

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Abstract

The high water content of *Lycopersicon esculentum* usually favors microbial growth, thus resulting in shelf-life reduction and economic loss. In an effort to develop an ecofriendly preservative for cherry tomatoes, a comprehensive study establishing the antimicrobial activity of the seeds of *Chrysophyllum albidum* and *Persea americana* was carried out. Folin Ciocalteu, $AlCl_3$ colorimetric, and agar well diffusion assays were, respectively, used to determine the total phenolic content (TPC), total flavonoid content, and the antimicrobial potential of the extracts. Although the ethanolic extract of *C. albidum* displayed the highest TPC (90.71 ± 2.17 mg/g GAE), the antimicrobial studies indicated that aqueous extract of *C. albidum* seed (CAA), which showed the presence of saponins (total saponin content: 7.82%) had the highest zone of inhibition against *Samonella typhi* (24.5 ± 0.05 mm) and *Pseudomonas aeruginosa* (22.5 ± 0.05 mm). Treatments with 50 and 100 mg/ml of CAA retained firmness in tomatoes and significantly ($p < .05$) preserved the postharvest qualities (total soluble solids, total acidity, and ascorbic acid content) of cherry tomatoes.

Novelty impact statement: Seeds of *Chrysophymum albidum* and *Persea americana*, which are usually discarded, possess antioxidant and antimicrobial phytochemicals with the aqueous extract of *C. albidum* (CAA) exhibiting more impressive antimicrobial properties. CAA treatment significantly preserved the postharvest qualities of cherry tomatoes. Hence, CAA is a cheap and easily affordable natural product treatment can be used to prolong the shelf-life of cherry tomatoes, thus minimizing economic loss due postharvest wastage of tomatoes.

1 | INTRODUCTION

Tomato (*Lycopersicon esculentum*) is widely accepted fruit vegetable which is rich in vitamins, antioxidants and contains a substantial amount of water (Bello et al., 2016; Hosea et al., 2017; Vignesh & Bindu, 2019). Tomatoes constitute a large part of the world's diet. In Nigeria, the annual production of tomatoes is about 1.8 million metric tons while the demand is about 2–3 million metric tons. About 50–65% of these produced tomatoes are wasted due to long distant transportation, climatic conditions, and microbial attacks (Arah et al., 2016; Ghosh, 2009; Ugonna et al., 2015). Post-harvest spoilage organisms which affect tomatoes include *Aspergillus spp.*, *Alternaria spp.*, *Fusarium oxysporum*, *Rhizopus stolonifer*, *Actinomycetes sp.*, *Salmonella typhimurium*, *Escherichia coli*, *Erwinia caratovora*, *Bacillus subtilis*, *Staphylococcus aureus*, and *Listeria monocytogenes* (Ghosh, 2009; Ibrahim et al., 2019).

In order to prevent this undesirable loss of tomatoes, several technologies have been developed. These include the use of ozonized water (for sanitizing the fruits), calcium chloride, 1-methylcyclopropene, refrigeration, modified atmosphere

packaging (MAP), UV radiation, edible coatings among others (Arah et al., 2016; Swetha & Banothu, 2018). In spite of the development of new technologies which have been employed in the preservation of tomato fruit, some concerns still exist. The cost of some of these technologies is high and in some cases, undesirable side effects are observed. Such side effects may sometimes include terminal (life threatening) diseases among others (Loaharanu & Ahmed, 1991; Olunike, 2014; Sharma, 2015).

These shortcomings have further necessitated the search for sustainable means of ensuring that the essential physicochemical properties are effectively preserved. Natural extracts from various readily available plant parts are a rich source of phytochemicals such as alkaloids, phenolics, flavonoids, etc. Many of these phytochemicals have been reported to be antimicrobial in nature. Hence, they can be used as edible fruit coatings to remedy the spoilage of farm products (Mogoşanu et al., 2017).

Several plant materials whose extracts have been employed as edible fruit coatings for tomatoes include *Moringa oleifera* seed, *Carica papaya* seed, and neem leaf powder (Hosea et al., 2017; Ibrahim et al., 2019; Olaleye et al., 2014). Extracts from *M. oleifera* (Ibrahim et al., 2019), *Lepechinia meyenii* leaves (Tayel et al., 2018), *Citrus aurantium* L. flower (Degirmenci & Erkurt, 2020), *Ferula caspica* aerial parts (Kahraman et al., 2019), *Equisetum telmateia* (Yeganegi et al., 2018), *Satureja bachtiarica* (Alghooneh et al., 2015) among many others have been reported to be active against spoilage organisms such as *S. aureus*, *Pseudomonas aeruginosa*, *B. subtilis*, *E. coli*, *F. oxysporum*, *S. typhimurium*, and *L. monocytogenes*. In the same vain, different essential oils have been utilized as active ingredients in the production of preservative edible coating materials (Behbahani et al., 2019; Kiarsi et al., 2020; Noshad et al., 2021; Tanavar et al., 2021).

Chrysophyllum albidum and *Persea americana* seeds have been applied for various medicinal purposes. Various extracts of *C. albidum* seed possess antidiabetic, antimicrobial, and antioxidant properties (Adeleye et al., 2016; Akin-osanaiye et al., 2018; Godwill et al., 2016; Oputah et al., 2016). Research reports also show that every part of *P. americana* is useful including the seeds which are relatively underutilized, with fungicidal, insecticidal, and antimicrobial activities (Dabas et al., 2013; Egbuonu et al., 2018). The objectives of this research were to phytochemically analyze the seed extracts from *C. albidum* and *P. americana*, determine their antimicrobial abilities and study the effect of the most active extract on the post-harvest physicochemical characteristics of cherry tomato fruits.

2 | MATERIALS AND METHODS

2.1 | Materials

Both African star apple (*C. albidum*) and avocado (*P. americana*) fruits were obtained from the local market in Omu-Aran, Irepodun Local Government area, Kwara State, Nigeria. Homegrown cherry tomatoes with the same degree of ripeness were harvested and immediately transported to the laboratory for postharvest analysis.

2.2 | Preparation of seed extracts

The seeds from *C. albidum* and *P. americana* fruits were washed, air-dried, and grounded into a fine powder (using Euro Premium Mixer Grinder, CMIL 7398801, Eurosonic, India). The powdered seeds (50 g) were macerated using 200 ml double-distilled water or ethanol at room temperature for 3 days (Barakat et al., 2017). The mixture was filtered and the extract solutions were concentrated using a rotary evaporator (Stuart, RE 300 dB, Bibby Scientific Limited, UK) resulting in *C. albidum* aqueous (CAA), *C. albidum* ethanolic (CAE), *P. americana* aqueous (PAA), and *P. americana* ethanolic (PAE) seed extracts. The extracts were refrigerated until further use.

2.3 | Total phenolic content (TPC)

The TPC of the plant extract was estimated by modifying the method used by Dhawan and Gupta (2016). The stock solution was used to prepare different concentrations of Gallic acid (10–1000 µl) and was used to make a calibration curve. Twenty microliters of the extract solution (1 mg/ml) was made up to 2 ml using water/ethanol. Approximately, Folin–Ciocalteu reagent (200 µl) and 7% sodium carbonate (500 µl) were added in each experiment. Incubation at room temperature was then followed for 1 h 30 min and the UV–Vis spectrophotometer (UV–Visible Spectrophotometer, Jenway-6705, UK) was used to measure the absorbance at 760 nm. The TPC (in mg/g GAE) was calculated as follows:

$$\mathrm{TPC} = c \times \frac{v}{m} \quad (1)$$

Where c is the gallic acid concentration derived from the gallic acid standard calibration curve (mg/ml), v is the volume of extract (ml), and m is the mass of extract in g.

2.4 | Total flavonoid content (TFC)

The TFC was determined by using an established method which was earlier adopted by Oluyori et al. (2018). Different concentrations of the rutin trihydrate were used as standard (10, 30, 60, 130, 250, 500, 750, and 1000 µl) and for the calibration curve. Precisely, 1 ml of the extract was added to 10% aluminum (III) chloride solution (in ethanol) and shaken vigorously. The mixture was incubated for 15 min at room temperature and the absorbance was taken using spectrumlab 755 s UV–Vis spectrophotometer at 430 nm. The TFC was estimated as Rutin equivalent (RE) in mg/g/g extract.

2.5 | Total saponin content

The total saponin content (TSC) was estimated in *C. albidum* aqueous seed extract using the method described by Ifemeje et al. (2014). In brief, 1 g of the extract was treated with 20% acetic acid in ethanol and allowed to stand in a water bath at 50°C for 24 h. This mixture

was filtered and the filtrate (extract solution) was concentrated using a water-bath to one-quarter of the initial volume. Afterward, concentrated NH_4OH was added drop-wise to the extract until the precipitation was complete. The whole mixture was allowed to settle and the precipitate was collected by filtration and weighed. The saponin content is then calculated *s* follows:

$$\%\,\text{Saponin} = \frac{W2 - W1}{\text{Weight of sample}} \times 100$$

Where, *W*1, weight of filter paper; *W*2, weight of filter paper + residue.

2.6 | Antibacterial studies

The test organisms: *Aspergillus flavos*, *Aspergillus niger*, *B. subtilis*, *E. coli*, *P. aeruginosa*, *S. aureus*, and *S. typhi* were obtained from the Microbiology department of Landmark University. The inhibitory effect of the extracts on the organisms was determined using agar well diffusion assay. While potato dextrose agar was the growth media for fungal isolates, Muller Hinton Agar was used for the bacterial isolates (Itelima et al., 2016; Oluwaniyi et al., 2016). Ciproflaxcin and ketozole were used as a positive control for bacteria and fungal assays, respectively, while distilled water/10% DMSO served as the negative control. After the experiment, the zone of inhibition was recorded in millimeters.

2.7 | Tomato preservation

2.7.1 | Effect of extracts on shelf-life

The aqueous extract from *C. albidum* was prepared at different concentrations of 25, 50, and 100 mg/ml with sterilized/distilled water. The samples of cherry tomato were dipped into the different concentrations of aqueous extract and sterile distilled water (as control) for 30 s, then removed and placed on ethanol disinfected platform. The tomatoes were sorted into different treatment groups with each group containing 8–10 fruits. The physicochemical properties of the tomato fruit were observed for 28 days (Khaliq et al., 2019; Moshari-Nasirkandi et al., 2020).

2.7.2 | Weight loss

The loss in weight for each tomato fruit was monitored during each experimental day using an analytical weighing balance (OHAUS Pioneer balance PA213, USA) (Khaliq et al., 2019). This weight loss (WL) was calculated as follows:

$$\text{WL}(\%) = \frac{Wi - Wf}{Wi} \times 100 \quad (2)$$

Where *Wi*, initial weight and *Wf*, final weight.

2.7.3 | Fruit firmness

The firmness of each fruit was determined by employing a hand squeeze. The degree of firmness was estimated by using the following scale: 10 = extremely firm to 2 = extremely soft (Khaliq et al., 2019).

$$\text{Firmness index} = \sum(\text{firmness scale} \times \text{percentage of fruit within each firmness class}) \quad (3)$$

2.7.4 | Total soluble solids (TSS) and total acidity (TA)

The fruit samples were grounded and filtered. The total soluble solids (TSS) were measured using a refractometer (WYA Abbe Refractometer, 709001, Kruss, Germany) and reported as percentages. The total acidity (TA) of samples was estimated by taking 5 ml of each fruit juice and diluting it with 45 ml of deionized water. The diluted juice with phenolphthalein indicator was then titrated with sodium hydroxide (0.1 M) with until pH 8.3 was attained. The TA was expressed in % citric acid (Moshari-Nasirkandi et al., 2020).

2.7.5 | Ascorbic acid content

The ascorbic acid content (mg/g fresh weight) was estimated as described by Dinesh et al. (2015) with minor modifications. Five grams of the fruit samples was grounded and mixed with 10 ml of 4% oxalic acid, then centrifuged for 15 min at 8000 rpm (using LW Scientific CS bench centrifuge, 122644, USA). Ten milliliters of 4% oxalic acid was added to 5 ml the clear solution was titrated against the dye—2,6-dichlorophenolindophenol.

2.8 | Statistical analysis

An IBM SPSS statistical software was used for the analysis. The different calculations were done and verified using one-way analysis of variance (ANOVA) at $p \leq .05$, using Tukey for the post hoc test.

3 | RESULTS AND DISCUSSION

3.1 | Qualitative and quantitative phytonutrient composition of the extracts

Preliminary phytochemical investigation on *C. albidum* aqueous (CAA), *P. americana* aqueous (PAA), *C. albidum* ethanolic (CAE), and *P. americana* ethanolic (PAE) seed extracts revealed the presence of alkaloids, flavonoids, saponins, phenolics, and terpenoids.

3.1.1 | Total flavonoid content (TFC)

Further, in the total estimation of the flavonoid content, it was observed that PAE and CAE extracts had the highest flavonoid content compared to the other extracts (Table 1). The values obtained for the flavonoid contents in PAE and CAE were 15.5 ± 0.35 and 5.75 ± 0.35 mg rutin/g of dry extract, respectively. The fact that flavonoid components were more abundant in the ethanolic extracts agree with the findings of Dibacto et al. (2021) where ethanol extract gave the highest flavonoid content among three solvents: ethanol, ethanol: water; 1:1 v/v and water.

3.1.2 | Total phenolic content (TPC)

CAE was found to contain the highest TPC among the extracts, followed by PAE and CAA while the lowest was PAA (Table 1). As inferred in total flavonoid content, high antioxidant capacity results from high total phenolic content. Generally, the ethanol extracts seemed to contain more of the phenolic and flavonoid compounds, compared to the aqueous extracts. The phenolic compounds exhibit their antioxidant function by making use of the hydroxyl group to scavenge free radicals (Kahraman et al., 2019; Vasile et al., 2019).

3.1.3 | Total saponin content (TSC)

The phytochemical screening did not suggest any major variation in the abundance of saponins in PAE and PAA. However, CAA demonstrated a notable presence of saponins while the saponins were not detected in CAE. The total saponin content of CAA was thereafter qualified as 7.82%. This TSC might have contributed to the antimicrobial activity of CAA as saponins have been earlier known to exhibit notable antimicrobial properties (Adelani-Akande et al., 2015). This inference is in tandem with Tagousop et al. (2018) who reported impressive antibacterial and antifungal activities for the methanolic extract and pure saponins from *Melanthera elliptica*.

3.2 | Antibacterial activity

Antibacterial activity of aqueous and ethanolic seed extract of *C. albidum* and *P. americana* was tested against *S.aureus*, *S.typhi*, *P. aeruginosa*, *B. subtilis*, and *E. coli*. The organisms were selected because they are documented among the several spoilage organisms which affect tomatoes. Results from the studies showed that CAA had the highest zone of inhibition of 24.5 ± 0.5 and 22.5 ± 0.5 mm against *S. typhi* and *P. aeruginosa*, respectively, PAA was second highest with a zone of inhibition of 22 ± 2 and 18 ± 1 mm against *S. typhi* and *P. aeruginosa*, respectively. Also, the antimicrobial activity of CAA and PAA can be attributed to the earlier established presence of saponins, flavonoids, and terpenoids. The works of Nwaoguikpe et al. (2011) confirmed that the antimicrobial potency of PAA against certain microorganisms was higher than that of PAE as stated in this study. Similarly, the antimicrobial result obtained for CAE and PAE was similar to those reported in the previous studies (Akin-osanaiye et al., 2018; Egbuonu et al., 2018). The results are depicted in Table 2.

3.3 | Tomatoes preservation

3.3.1 | Weight loss

Water is the most abundant nutrient in fruits. However, water content varies between individual fruit of the same type because of structural difference. It may also be affected by cultural conditions, which influence cultural differentiation. Hence, weight loss is a major observation during the storage of tomatoes. The loss in weight observed in CAA-treated tomatoes and control were observed during a 28 days storage. Although loss in weight was recorded in all

TABLE 1 Quantitative phytochemical analysis on ethanolic and aqueous *P. americana*, and *C. albidum* seeds

Phytochemical Content	Ethanol extract		Aqueous extract	
	PAE	CAE	PAA	CAA
TFC (mg/g RE)	15.5 ± 0.35	5.75 ± 0.35	3.25 ± 0.35	4.0 ± 0.71
PC (mg/g GAE)	41.51 ± 0.43	90.71 ± 2.17	20.75 ± 0.22	25.67 ± 0.22
TSC (%)	ND	ND	ND	7.82 ± 0.94

Note: Mean ± standard deviation ($n = 2$).

Abbreviations: CAA, *Chrysophymum albidum* aqueous extract; CAE, *Chrysophymum albidum* ethanolic extract; ND, not determined; PAA, *Persea americana* aqueous extract; PAE, *Persea americana* ethanolic extract.

TABLE 2 Zone of inhibition of some selected microorganisms by the extracts

Microorganisms	Negative control	Positive control	PAE	CAE	PAA	CAA
S. aureus	NA	35.5 ± 0.5^{a}	18 ± 1.0^{b}	10 ± 0.5^{c}	14.5 ± 0.5^{b}	15.5 ± 0.5^{b}
S. typhi	NA	24.5 ± 0.5^{a}	14.5 ± 0.5^{b}	19.5 ± 0.5^{c}	22 ± 2.0^{ac}	24.5 ± 0.5^{a}
P. aeruginosa	NA	54 ± 2.0^{a}	14.5 ± 0.5^{bc}	14 ± 2.0^{c}	18 ± 1.0^{cd}	22.5 ± 0.5^{d}
B. subtilis	NA	29.5 ± 0.5^{a}	NA	16 ± 1.0^{b}	13.5 ± 0.5^{bc}	12.5 ± 0.5^{c}
E. coli	NA	25.5 ± 0.5^{a}	14.5 ± 0.5^{b}	NA	NA	NA
A. flavos	NA	21.5 ± 0.5	NA	NA	NA	NA
A. niger	NA	14.0 ± 1.0	NA	NA	NA	NA

Note: Each value represents mean ± SEM. Values with different letters within the same column are significantly different at ($p < .05$).
Abbreviations: CAA, *Chrysophymum albidum* aqueous extract; CAE, *Chrysophymum albidum* ethanolic extract; PAA, *Persea americana* aqueous extract; PAE, *Persea americana* ethanolic extract.

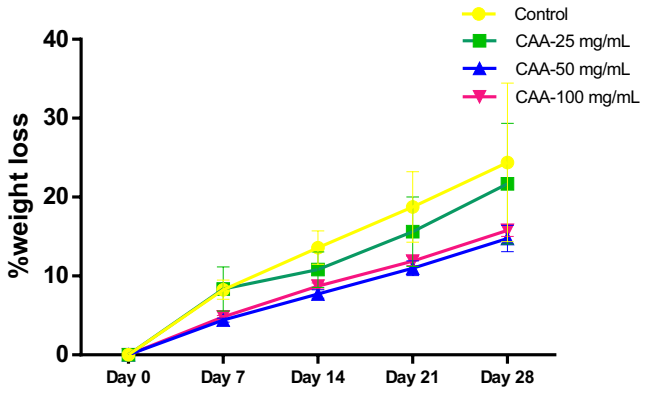

FIGURE 1 Effect of *C. albidum* aqueous extract (control, 25, 50, and 100 mg/L) on %weight loss in cherry tomatoes.

the tomato fruit samples, results indicate that the tomatoes treated with 50 mg/ml extract had the lowest level of weight loss followed by 100 mg/ml, with the control having the highest weight loss. This is similar to the trends that have been earlier observed by Banu et al. (2020) and Khaliq et al. (2019). The edible coatings obstructed the exchange of oxygen, water vapor, and carbon dioxide thereby controlling moisture loss (Banu et al., 2020; Moshari-Nasirkandi et al., 2020). The overall weight loss data are presented in Figure 1.

3.3.2 | Fruit firmness

The firmness of fruit is one major attribute that determines the consumer's decision and shelf life. This can be observed by the texture of the fruit surface. Generally, tomatoes progress from fresh/firm to slightly firm before degenerating into appearance of dots and oozing of water/decay (Banu et al., 2020). Even if it has not decayed, once the texture of tomatoes become soft, their market value drops drastically. The sensory evaluation of the texture (hand squeeze) was based on the scale 10 (Extremely firm) to 2 (Extremely soft). Although the firmness of fruits decreased gradually in all the treatments (Figure 2), the tomatoes treated with CAA (100 mg/ml) and (50 mg/ml) delayed loss of firmness compared to the control and CAA 25 mg/ml (Table 3).

3.3.3 | Total soluble solids (TSS) and total acidity (TA)

Soluble solid content is an important indication of the maturity phase of any fruit. It was observed that there was an increase in TSS of CAA-100 mg/ml treated tomatoes but that it declined from day 14 (Table 4). The increase in TSS of tomato fruit treated with CAA 100 mg/ml might be due to the breaking down of insoluble polysaccharide into simple sugar. Thereafter, a decrease related to the slow decomposition rate during the respiration cycle was noticed as observed in previous studies (Hassanpour, 2015). Khaliq et al. (2019), noticed a similar trend for the TSS content in sapodilla fruit coated with *Fagonia indica* extract treated—aloe vera gel. The TSS content increased until day 9 and started decreasing from day 12.

Titratable/total acidity is also an index for estimation of the state of fruits during storage. The TA content varies owing to the ripening of various fruits during storage. The outcomes showed that TA gradually decreased in all the cherry tomato samples with time throughout the period under study (Table 4). The aqueous cherry extract with 50 and 100 mg/ml significantly preserved the TA compared to the control from day 7 to day 14 ($p < .05$). The TA value of the 50 mg/ml treated tomatoes decreased from 0.68 to 0.4 while that of 100 mg/ml treated tomatoes decreased from 0.63 to 0.45 after day 14. The presence of sugar and organic acids is responsible for the sweet taste and flavor of fruits and these organic acids are used up during respiration (Hassanpour, 2015; Khaliq et al., 2019). Hence, as shelf-life duration increases, the acidity decreases. The CAA extract hindered oxygen interaction thereby inhibiting the respiration process and thus resulting in higher TA values of treated tomato fruits (Hassanpour, 2015; Khaliq et al., 2019).

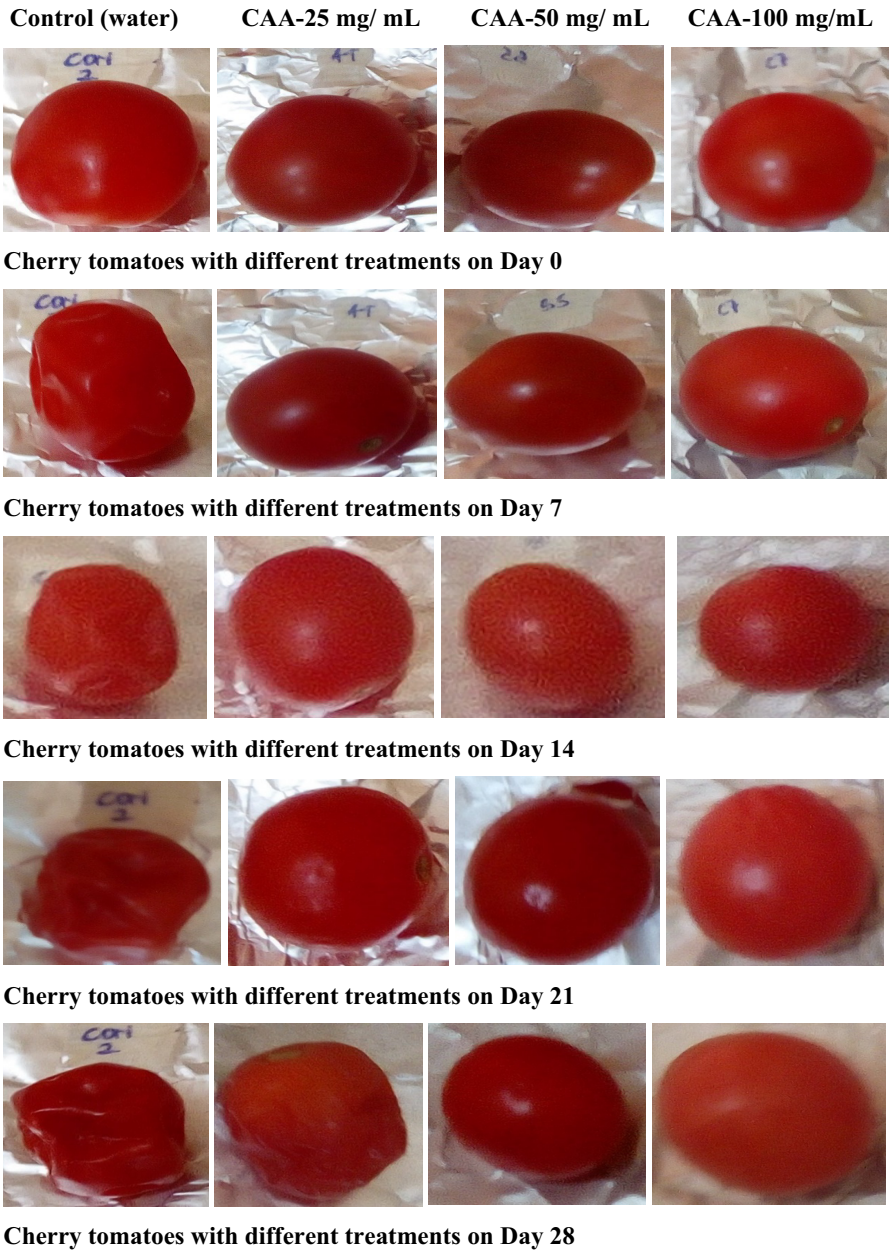

FIGURE 2 Effect of different concentrations of CAA extract on the texture of coated tomatoes during storage.

TABLE 3 Firmness of cherry tomatoes fruit coated with *C. albidum* aqueous seed extract on day 28 of storage

Treatments	Texture
Control	7.17 ± 0.24
25 mg/ml	7.22 ± 0.16
50 mg/ml	8.78 ± 0.47
100 mg/ml	7.83 ± 0.86

Note: Mean ± standard deviation ($n = 3$).

3.3.4 | Ascorbic acid content

The ascorbic acid content in fruits is usually dependent on the species, planting conditions, and storage duration. Ascorbic acid is a well-known antioxidant that inhibits oxidation reactions during the ripening process and can be used to predict the shelf life of fruits. Previous reports show that the ascorbic acid content of the tomato fruits generally decrease drastically during storage (Banu et al., 2020). However, the CAA extract delayed this process as shown in Table 4. CAA 100 mg/ml was more effective in conserving the ascorbic acid content of tomato fruit up to day 7, then a decrease was noticed from day 14. This showed that a significant difference exists between control group and CAA 100 mg/ml ($p < .05$). Mendy et al. (2019) recorded that the ascorbic acid content of papaya fruit increased at the beginning of the study, then declined at the end. This trend is also in line with results by Banu et al. (2020). On the 28th day, the highest ascorbic acid content (3.4 mg/ml) was observed in the tomato fruit treated with 50 mg/ml of CAA. This observation is worthy of further attention and investigation.

TABLE 4 Effects of different concentrations of CAA on total soluble solids, titratable acidity, and ascorbic acid content of cherry tomatoes during 28 days storage period

Total soluble solids					
Treatments	0	7	14	21	28
Control	1.51 ± 0.01	1.49 ± 0.00^{a}	1.44 ± 0.00^{a}	1.39 ± 0.00^{a}	1.39 ± 0.00^{a}
25 mg/ml		1.51 ± 0.00^{bd}	1.47 ± 0.00^{b}	1.40 ± 0.00^{ab}	1.39 ± 0.00^{a}
50 mg/ml		1.51 ± 0.00^{cd}	1.49 ± 0.00^{cd}	1.41 ± 0.00^{bc}	1.41 ± 0.00^{bc}
100 mg/ml		1.52 ± 0.00^{d}	1.50 ± 0.00^{d}	1.42 ± 0.00^{c}	1.41 ± 0.00^{c}
Titrable acidity					
Control	0.68 ± 0.02	0.45 ± 0.02^{a}	0.34 ± 0.04^{a}	0.29 ± 0.02^{a}	0.26 ± 0.01^{a}
25 mg/ml		0.49 ± 0.01^{a}	0.47 ± 0.02^{a}	0.37 ± 0.03^{a}	0.33 ± 0.02^{a}
50 mg/ml		0.5 ± 0.01^{a}	0.68 ± 0.08^{a}	0.4 ± 0.03^{a}	0.38 ± 0.02^{a}
100 mg/ml		0.66 ± 0.02^{b}	0.63 ± 0.02^{b}	0.45 ± 0.02^{a}	0.39 ± 0.04^{a}
Ascorbic acid content					
Treatments	0	7	14	21	28
Control	11.25 ± 0.15	10.5 ± 0.10^{a}	5.5 ± 0.09^{a}	3.3 ± 0.13^{a}	1.05 ± 0.05^{a}
25 mg/ml		10.85 ± 0.05^{a}	7.33 ± 0.18^{b}	3.7 ± 0.18^{a}	2.41 ± 0.15^{b}
50 mg/ml		10.95 ± 0.05^{a}	9.29 ± 0.05^{cd}	4.9 ± 0.09^{a}	3.4 ± 0.53^{a}
100 mg/ml		11.3 ± 0.1^{b}	9.43 ± 0.09^{d}	5.0 ± 0.04^{a}	2.82 ± 0.05^{c}

Note: Each value represents mean ± SEM (standard error of the mean). Values with different letters within the same column are significantly different at ($p < .05$).

4 | CONCLUSION

The results from this research have proved that *C. albidum* aqueous extract was successfully employed in the preservation of cherry tomato fruits, as shown by the sensory evaluation as well as total soluble solids, titrable acidity, and ascorbic acid content indices. This is the first report of the application of *C. albidum* seed extract as a natural agent in the preservation of tomatoes. The higher concentrations of CAA (50 and 100 mg/ml) were able to offer significant preservative effect ($p < .05$) on the post-harvest characteristics of cherry tomatoes. Hence, CAA can be conveniently applied in the food industry as a safe and cheap natural preservative.

AUTHOR CONTRIBUTIONS

Abimbola P. Oluyori: Conceptualization, benchwork, article writing; Adewumi O. Dada: Article writing; Temitope A. Ogunnupebi: Benchwork, article writing; Akinyomade O. Owolabi: Antimicrobial assay; Tabitha A. Adelani-Akande: Antimicrobial assay; Adejumoke A. Inyinbor: Article writing.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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