Evaluation of Physicochemical Quality of Habanero Pepper Preserved with Powder of *Annona Muricata* (Linn.)

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ABSTRACT

Habanero Pepper or *Capsicum chinense* (Jacq.) is a highly perishable fruit. Different methods of preservation have been utilized over the years to reduce the losses from spoilage. Chemical preservatives are expensive and may be harmful to humans. Leaf extracts of *Anona muricata* (L) have been reported to have antimicrobial, antioxidant and anti-inflammatory properties and have been used to preserve tomatoes. There is limited information on the retention of the physico-chemical quality of fruits preserved with extracts *A. muricata* This study therefore evaluated the physicochemical quality of Habanero Pepper preserved with powder of *A. muricata*

Fully ripe *C. chinense* purchased from the local market were selected washed. They were dipped and treated with 10% (w/v) each of aqueous and ethanol extracts of the plant at different concentrations (3%, 5%, 6%, 9% and 12%) for 30 minutes. The fruits were placed in a well-ventilated room for two weeks after which physicochemical (percentage weight loss, appearance, decay percentage, proximate, chlorophyll, capsaicin, vitamins and antioxidants). Data were analysed using descriptive statistics (frequency).

The percentage preservation of *C. chinense* was 71.75%. The physicochemical qualities evaluated were percentage weight loss (34%); appearance (6.88); decay percentage (75%); capsaicin (12.10mg/g); moisture content (58.57%); protein (1.87%); fat (1.77%); ash (3.13%); carbohydrate (5.57%); fiber (32.4%); ascorbic acid (6.63mg/100g); Riboflavin (0.23mg/100g); Total phenolics (96.70GAE/g, 93.67GAE/g); carotenoids (820µg/100g, 826µg/100g); antioxidant (FRAP) 0.10 $MnFe^{2+}$/kg). This study concluded leaf extract of *A. muricata* can improved the shelf life of *C. chinense* while maintain its physicochemical qualities. Therefore extracts of *A. muricata* could be used by farmers after harvest to preserve their produce before reaching the consumers

Keywords: Shelf life**,** Capsicum *chinense, A. muricata* leaf extract, physicochemical qualities

INTRODUCTION

Peppers (*Capsicum spp.)* belong to Solanaceae family. They are considered the first spice to have been used by human beings (Nwaogu, 2021). Pepper is cultivated in many regions of the world and there is an increase in for it, due to its culinary and vegetable uses.

Pepper is of great importance in Nigeria, it ranks third among vegetables cultivated in the country**,** and also amongst nations in Africa, Nigeria has the largest output of pepper. The pepper plant is cultivated mainly with irrigation in the northern part of Nigeria (Ogunbo, 2015; Nwaogu et al., 2021). There are different types of pepper namely Chili pepper, bell pepper, Cayenne Pepper, Bird's Eye Chili, Scotch bonnets or Habaneros.

Habanero pepper (*C. chinense)*, called Atarodo in Yoruba, Ose Oyibo among Igbos and Atarugu in Hausa.

Habanero pepper fruits serves as good sources of vitamin C and E. They also possess carotenoids, peptides, flavonoids, polyphenols, and capsaicin oids. The fruits have anticancer, anti-inflammatory and antioxidant properties (Sosa-Moguel et al., 2017; Chel-Guerrero et al., 2021).

They are used as raw materials of many industries; food industry in the production of sauces, pepper sprays, creams, ointments, and chemicals. They are also used in the production of electric wire coatings and paints (Ekhuemelo et al., 2018; Muñoz-Ramírez et al., 2020). Pepper is also used in the control of diseases pests of plants (Ekhuemelo et al., 2018).

Ripe habanero is usually red in colour though some varieties are orange when ripe. How ever the unripe fruit is green. In spite of its high production, pepper is a highly perishable commodity, after its harvest, a great loss occurs because the fruit undergoes continued respiration and transpiration. Many post-harvest changes occurs in the fruits which include change in colour, water loss and fruit decay caused by fungal attack to the extent that the fruits becomes unfit for human consumption leading to a huge annual loss (Nwogu, 2021).

There are many methods that have been utilized in finding ways to improve the shelf life of Habanero pepper. (Nwaogu et al., 2021 ; Banjo et al., 2022 ; Ikechi -Nwogu et al., 2022). However, there are no studies on the use of plant extracts, to extend the shelf life of Habanero pepper.

Annona muricata(sour-sop) a member Annona ceae family. It is a plant that grows in the tropics. Its fruits are edible. Extracts of *A. muricata* have antimicrobial, antioxidant and anti-inflammatory properties (Abdel-Rahman et al., 2019). The plant serves as a good source of many compounds which include tannins, alkaloids, saponins, flavonoids, phenols and acetogenins. It also contains mineral salts and vitamins (Coria-Téllez et al., 2018).

Recently, A. *muricata* has been used to preserve fresh tomatoes (Banjo et al,2022). Therefore, the aim of this research is to investigate the effect of A. *muricata* extract on shelf life extension of Habanero pepper.

MATERIALS AND METHODS

2.1 Collection and Identification

Leaves of *Annona muricata* were collected from the surrounding fields of Department of Microbiology, University of Ibadan and were re-identified, and the nomenclature rechecked and confirmed by the help of a plant taxonomist. Habanero pepper selected were fully ripe and red in colour. Those with deformity, were removed.

2.2 Preparation of Plant Materials

The leaves of *Annona muricata* plant were dried in the shade for two weeks at room temperature. The dried plant materials were ground into powder by a blender. The resultant was sieved with a 1.0 mm sieve and stored in an airtight container until further use.

2.3Preparation of ethanol extracts

Ten grams of the dried plant powder was added to 100 mL (10% w/v) ethanol inside a conical flask and corked tightly (Banjo et al., 2022). The resultant was placed on a vibrator for 2 days.

2.4 Preparation of water extract.

Ten grams of the dried plant materials was measured into 100 mL (10% w/v) of previously sterilized distilled water (Banjo *et al*. 2022). The resultant was then be placed on the vibrator for 2 days.

2.5 Effect of solvent type on shelf life of Habanero fruits.

2.5.1Effect of the Ethanol extracts on the fruits:

Eight previously washed fruits i.e. Okra and Habanero were placed in labelled beakers of 100 ml of ethanol for

30mins. Afterwards, the fruits were removed from the extracts and placed in a well ventilated room.

2.5.2 Effect of the Aqueous extracts on the fruits:

The procedure was repeated as above, but the fruits were soaked in aqueous extracts.

2.5.3Effect of plant powder on the fruits preservation

Powder of *Annona muricata* leaves, were used to coat each of the fruits with the powder and kept in a well-aerated place (Banjo et al., 2022). Another set of fruits, without any treatment served as the control.

2.6 Measurements of physicochemical characteristics of Habanero pepper

2.6.1 Proximate Composition

The pepper samples were dried in the oven until a constant value is obtained so as to get the moisture content of the pod .The dried mass was used to calculate the values of ash, crude fat, crude protein as well as the fiber content. As described in the AOAC methods.

Also carbohydrates was calculated by differences, (Manzi et al. 2004).

2.6.2 Vitamin and ph of pepper samples

Ascorbic acid; Pepper fruits(30µg) already milled was mixed thoroughly with 500µml twelve percent oxalic acid The resultant was titrated against 0.1% dichlorophenol indophenol, the titer value was used to calculate the ascorbic acid content as mg ascorbic acid/100g fruit material (Awole et al., 2013).

Riboflavin

Ground dried fruit(10g) was dissolved in volumetric flasks insoluble solids was filtered through Whatman #1 filter paper, the filterate liquid used for assay at pH 7.52, using sodium borate buffer. The absorbance was monitored at 440nm in spectrophotometer (Bartzatt &Wol, 2014).

Thiamine

Pepper fruits (10g) were ground and added to 20mg of and dissolved in 100 ml of water using calibrated flask. 5ml of sodium hydroxide solution and 5ml of hydrogen peroxide were added to oxidize the thiamine and heated in a water bath at 75 °C, 4 mL of 5% BaCl2 in 4 M HClO4 was added for formation of $BaSO_4$. Then 4 mL of glycerol: ethanol (2:1) solution was added.

The mixture was diluted to 25 mL with deionized water, shaken and cooled. The absorbance and transmittance were measured at 420 nm against blank (Al-Ahmary &Khairia, 2014).

Niacin

Ten gram of finely ground dried fruit was accurately weighed into a beaker and thoroughly shaken. The solution was made up to 10 mL with the same solvent to provide a theoretical 0.001 g/mL solution of niacin. Serial volumes similar to the one prepared for the general procedure were transferred to different test tubes and treated similarly before analysis at 464 nm against a methanol blank (Nwanisobi &Ukoha, 2016).

2.6.3. Measurements of oxidants and pigment of pepper samples

Capsaicin. This involves the extraction of Capsaicin, 0.9 L ethanol (96%) was added to 1000mgpowder of dried pepper pods and heated. After four hours of heating, 0.9L of methyl alcohol and black carbon was added and homogenized on a hot plate stirrer for half an hour. This was sieved by membrane filter. The filtrate was monitored in a spectrophotometer at an absorbance of 248nm. Acidic and alkaline blanks were prepared by adding 300µ ml of water to 200µ ml of HCl and 200µ ml of NaOH solutions respectively and diluting each by methanol. (Awole etal., 2013).

Moisture content: Treated pepper fruits were dried in an oven at 70 °C and re weighted until a constant value is obtained. The moisture content was calculated thus.

Moisture content % $=\frac{M-m}{Mx100}$.

Where M weight before drying the pods; m is weight after drying the pods

Physiological weight loss (PWL)

The pepper fruits weight was measured at the start of the experiment and at 4 days interval for 4 weeks. Using a digital scale and the percentage of weight loss was determined by calculating thus;

Weight loss% $=\frac{W-w}{Wx100}$.

Where W is initial weigh and w is final weight (Waskar et al., 1999).

Percentage marketable fruits

The acceptability of the appearance of the pepper fruits was evaluated with the help of a team of panelists using a scale rating of 1-10, i.e. from excellent to very poor (Mohammed et al., 1999). Fruits that received a rating of five and above were considered marketable while those rated less than five were considered unmarketable.

Decay % of pepper fruits: Total percentage fruits' spoilt was expressed as $\frac{totalnumberoffruitdecayed}{Initialtotalnumberoffruit}$X100

Statistical data analysis.

Mean and standard deviation of three replicates of data were analyzed while the significance of the effects of the powder of the leaf of *Annona muricata* on the extension of shelf life of habanero pepper were estimated with ANOVA Significant level is taken as p< 0.05. Differences in means of different treatments was determined by Duncan's Test. Significant level is taken as p< 0.05.

RESULT AND DISCUSSION

The habanero coated with the powder of the leaf of *A. muricata* had the highest number of fruits preserved after 14 days, 25% of the fruits were preserved. The control was not treated with any extract and had only 30% of the fruits preserved on the 10th day and by the 15th day all the fruits were spoilt The powder of *A. muricata* showed a significant on the shelf life of the habanero pepper fruits at $p < 0.05$. The fruits coated with aqueous and ethanol extracts of the leaf had lower rates of preservation. The mean preservation rate of the aqueous and ethanol extracts and the control for habanero were 62.5%, 41.5% and 48.75%, respectively (Table 1).

Table 1: Effect of *A muricata* leaf extract on pepper samples.

Time(days)	Aqueous Extract	Ethanol Extract	Powder	Control
1	100	100	100	100
5	83	50	90	65
10	67	16	72	30
15	0	0	25	0

Proximate composition of fresh, treated and untreated pepper samples. Moisture content in the pepper samples were 81.93 ± 0.36% and73.17±0.15% for the treated and untreated samples respectively (table 2) which shows a decrease, this is probably due to low relative humidity of the area at the time of the year. However the water loss is higher in the untreated samples this is agreement with El-Shaieny et al, 2022, water loss would lead to the concentration of nutrient content and reduce microbial activities. The protein content increased in storage in the untreated and treated samples respectively. This is not in agreement with Ngure et al 2008 and Ngure et al 2009 who showed that storing fruits at ambient temperature leads to degradation of protein in fruits. But the plant extract helped to prevent loss in protein content probably due to the bioactive component in the *A. muricata* leaf. Protein increase may be due to the loss in water content which helped to concentrate the protein content, also the plant extract helped to retain the protein content by reducing hydrolysis of protein. This agrees with the work of Audu et al, 2015 and Etawere &Etawere, 2019). Crude fat content increased during storage in the treated pepper samples while the value in the control was 1.6±0.15% .Fat is needed in the metabolism in tissues of plants and the rate of metabolism increase with temperature but the rate of fat degradation for metabolism decreased because the plant extract helped to improve their metabolism confirmed by Audu et al, 2015 and El-Shaieny et al,2022.The ash content increased in storage in the treated pepper sampls the ash content reflect the amount of mineral retained in the samples. It is expected that high temperatures reduce ash content (Audu et al, 2015), also okra samples treated with stimulant stored at low temperature had more ash content than those stored at 25°C.This shows that the plant extract helped to reduce mineral loss in the samples. The crude fibre content of the samples increased in storage. This is because fiber content increases with time and temperature after harvest (Eze and Akubo, 2012). Also other nutrients are being degraded thereby increasing the fibre content, this is in line with El-Shaieny et al, 2022. However for pepper storage is expected to lead to fbre loss regardless of the temperature of storage (Akinyemi et al,2018).

Carbohydrate: The carbohydrate content increased from this disagrees with Akinyemi et al, 2018 who reported reduction carbohydrate content in pepper in storage, but El-Shaieny et al, 2022reported Increase in okra pods when treated with bio stimulants.

Table 2: Proximate composition of fresh, treated and untreated pepper samples.

Parameter	Fresh Pepper	Treated Pepper	Untreated Pepper(control**)**
Moisture Content ^	73.17^{a}±0.15	58.57^{a}±0.15	55.23^{b}±0.21
Protein %	1.37^{a}±0.15	1.87^{b}±0.15	2.2^{c}±0.15
Ether Extract (Fat) %	1.13^{a}±0.15	1.77^{b}±0.1	1.6^{b}±0.15
Ash %	1.77^{a}±0.15	3.13^{b}±0.15	2.93^{b}±0.15
Crude Fibre %	3.87^{a}±0.15	5.57^{a}±0.15	6.03^{b}±0.15
Carbohydrates (By Diff) %	18.7^{a}±0.15	32.43^{a}±0.15	28.63^{b}±0.15

Values are means of three (3) replications ± standard deviation. Means within a row with same letters were significantly different (P<0.05). Means in brackets are in dry weight basis

Ascorbic acid, thiamin, riboflavin and niacin increased in storage both fruits (table3), this disagrees with Ngure et al, 2009: Kanwal et al, 2020 who reported that Vitamins are sensitive substances and can be degraded by temperature increase, (Kanwal et al, 2020) and that storing commodities at a low temperature, low oxygen and CO2 decreases the loss of vitamin. However the plant extract helped to retard vitamin loss because of their bioactive compounds.

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Table 3 Vitamin and ph. of pepper

Parameter	Treated	Untreated
Ascorbic Acid (mg/100g)	7.63±0.12	7.47±0.17*
Thiamin (mg/100g)	0.26±0.01	0.22±0.01
Riboflavin (mg/100g)	0.17±0.17	0.15±0.08*
Niacin (mg/100g)	2.14±0.12	1.91±0.01
P^H	6.4	6.4

Values are means of three (3) replications ± standard deviation.

Oxidants and pigments of the pepper samples.

Total Phenolic Compounds (TPC): There were no significant change in in the phenolic content of the pepper samples under storage which disagrees with (Mansor et al, 2021; Rodrigues de Queiroz et al., 2023) that reported a decrease in the phenolic compounds. The plant extract helped to prevent the degradation of the phenol probably due to the phenolic content of the plant extract.

Carotenoids: The value of carotenoids in the treated fruits was higher than that of the control (Table4). This may be as a result of anti-oxidant property of the plant extract helping to augment the antioxidant activity of the fruits.

Chlorophyll Pigments The value of the chlorophyll was higher in the treated okra samples than in the control this agrees with Al-Dabbas et al, 2023. We can only deduce that the It is obvious that plant extract play a role in protected the okra pod pigments from degradation, especially during high temperature (Rodrigues de Queiroz et al.,.2023).

Table 4: Oxidants and pigment of pepper samples

Parameter	Treated	Untreated
Total Phenolics (*GAE/g)	94.67±0.17	110±4.08
Carotenoids (µg/100g)	820±5	885±5
AntiOxidants (ORAC) % Inhibition	32.43±0.21	25.2±0.2
AntiOxidants (FRAP) (mM Fe^{++}/Kg)	0.11±0.015	0.08±0.01
Capsaicin (mg/g)	12.13±0.15	9.63±0.15

Values are means of three (3) replications ± standard deviation.

Antioxidant Activity of the pepper increased with storage this may be due to flavonoids and phenolic present in the plant extracts. Anti-oxidant activity reduces when phenolic compounds are oxidized (Al Dabbas et al, 2023). In general the fruit treated retained most of the post-harvest quality parameters.

CONCLUSION

Plan**t** **e**xtracts are regarded as safe and are being recommended for food preservation. They are effective in preserving food and are not likely to interfere with body metabolism. Fruit of habanero pepper preserved with the extract and powder of *A. muricata* have most of their physicochemical qualities maintained and so the preservation of fruits with extract and powder *A. muricata* is recommended for use by farmers and pepper sellers in situation of delays in sales of the fruits.

Conflicts of Interest: The authors declare no conflict of interest.

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