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Effect of Postharvest Treatments on Shelf Life and Quality of Pepper

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Authors' contributions

This work was carried out in collaboration between all authors. Authors MO and AF are the supervisors and reviewers of the work. Author BK performed laboratory experiments and wrote the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted to study the effect of chlorine, packaging materials and storage condition on quality and shelf life of pepper. Fruits and vegetables are sources of digestible food. Peppers are good sources of carbohydrates, vitamins and minerals and are considered as staple source of stew and soup ingredient in Nigeria. Pepper are highly perishable, proper handling of pepper will enable it to store for some weeks. Pepper were stored in four different storage methods: non–treated and stored in evaporative cooler, non-treated stored in basket, treated with chlorine and stored in basket and treated with chlorine stored in evaporative cooler. All kept at ambient (Temperature 25-28°C & relative humidity 70-90%) condition. The sack wall of evaporative cooler and basket was constantly wet with water. Data on physiological weight loss (%), decay (%), non-marketability (%), shelf life (days), total soluble solid (TSS), tritrable acid (TA) were taken. At 21 days of storage period, pepper treated and stored in evaporative had 44.76% marketability while other treatments had more than 67% pepper fruits were non-marketable. With the use of evaporative cooler, shelf life of pepper had extended up to 21 days as compared to non-treated and without packaging.

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1. INTRODUCTION

Fresh pepper (*Capsicum annuum*) is highly perishable and preferentially consumed in fresh forms; in consequence, the fruit quality and shelf life are important factors in its commercial value. Red pepper is one of the few foods that contain lycopene, a carotenoid whose consumption has been inversely correlated with cancer. Consumption of vitamin C, beta-carotene, and folic acid, all found in bell peppers, is associated with a significantly reduced risk of cancer [1]. Temperature management is the most effective tool for extending the shelf life of fresh horticultural commodities. Cooling pepper as soon as possible after harvest will extend their shelf life. Once the fruit is cooled, pepper can be stored for two to three weeks under the proper conditions [2].

The losses in vegetable quality and quantity between harvest and consumption affect the crop productivity. It is estimated that the magnitude of the postharvest losses of fresh vegetable crops is from 5 to 25% in developed countries and 20 to 50% in developing countries [3]. Admitting to inadequate information on appropriate postharvest treatments; packaging, storage conditions etc., the fruits not only lose their quality but also encounter a great postharvest loss. The research efforts have helped to increase the production of pepper but to obtain maximum profit, similar efforts will be required to minimize the postharvest losses and ensures a lasting shelf life. However, all intervention must meet the principle of cost effectiveness, because it will be difficult for a small scale farmer to afford the expensive and work intensive technologies.

The postharvest quality status and shelf life of the fruits depend on some postharvest handling practices and treatments carried out after harvest. The quality of any fruit after harvest cannot be improved by the use of any postharvest handling practices or treatment methods, it can however be maintained. Shelf life of the fruit can also be extended when appropriate postharvest handling practices and treatment methods are employed. Failure to adhere to these best practices has resulted in high amount of loss especially in developing countries. Quality is a complex perception of many attributes that are simultaneously evaluated by the consumer either objectively or subjectively. The brain processes is the information received by sight, smell, and touch and instantly compares or associates it with past experiences or with textures, aromas, and flavors stored in its memory. For example, just by looking at the colour, the consumer knows that a fruit is unripe and that it does not have a good quality. Quality of pepper is a complex feature as it includes among other characteristic parameters of colour (related to chlorophyll and carotenoid content), firmness, soluble solid, dry matter, and vitamin C content [4]. In many countries of the world fruits and vegetable are washed in chlorine or potassium permanganate before packaging [5]. This is carried out in order to reduce micro flora especially bacteria from the produce. Chlorine water is achieved by adding 200 PPM sodium hypochlorite in clean water [6].

[7] reported result on effect of packaging material and different storage regimes on shelf life and biochemical composition of pepper fruit. Fresh fruits and vegetables are generally packed in bamboo baskets, plastic crates, plastic bags, or nylon sacks for transportation, in Nigeria. Often, they are transported in an unpackaged form. After harvest, fresh fruits and vegetables are generally transported from the farm to either a packing house or distribution center. Farmers, especially small scale normally sell their produce either in fresh markets or in wholesale markets. At the retail level, fresh produce is sold in an unpackaged form, or is tied in bundles. This type of market handling of fresh produce greatly reduces its shelf life if it is not sold quickly. The application of proper postharvest technologies, would, however, increase postharvest shelf life, retain fresh quality and reduce losses. Packaging has been reported to significantly reduce fruit weight loss [8]. In Nigeria pepper farming is affected by rough handling, high temperature and relative humidity, spoilage microorganism due to very poor sanitation measures of our low income resource farmers etc. all these makes Nigeria environment unfriendly for fruits, thus leading to quantity and quality deterioration of fruits. Cooling methods are expensive for small-scale peasant farmers, retailers and wholesalers in Nigeria as they require high initial capital and power sources. It was against this back ground that the present study was conducted for solutionary measures. This experiment was carried out to determine the effect of postharvest treatments on quality and shelf life of pepper.

2. MATERIALS AND METHODS

Freshly harvested pepper fruits from the experimental plot of University of Agriculture Makurdi, Nigeria. The fruits were harvested with stalk based on visual maturity determination and subjected to shelf-life studies. Uniform unblemished fruits having similar colour and size was sorted out and hand wash with clean water to remove field heat and soil particles. Each treatment had a sample size of 40 fruits at each level, pepper was dipped in chlorine (200 ppm) for 5 minutes, spread under shade to dry and packaged based on their treatment and was assessed for quality and shelf-life over the storage period. The experiment was laid out in Complete Randomised Design factorial with three replications. Samples of the fruits are classified based on treatments as below:

a) Non- treated packaged in polyethylene in foam in plastic basket (evaporative cooler) =Treatment A
b) Non-treated packaged in plastic basket= Treatment B,
c) Chlorine treated packaged in plastic basket, =Treatment C, and
d) Chlorine treated packaged in polyethylene in foam in plastic basket (evaporative cooler) = Treatment D.

All treatments were stored in ambient condition: Temperature 25-28°C and relative humidity 70-90%. Laboratory experiments were carried out in Biological Sciences laboratory of Benue State University Makurdi, Nigeria, during late November to early December to determine the effect of treatments and packaging material on the quality and shelf life of pepper fruits. Samples of the fruits were taken every 7 days interval and assessed for their qualities for 21 days.

2.1 Physiological Analysis

2.1.1 Physiological weight loss (%)

The physiological weight loss (PWL) was determined according to the method of [9]. PWL was calculated for the storage days and converted to percentage of initial weight recorded for each sampling interval. Obtained values of PWL were expressed in percentage with respect to different treatments.

2.1.2 Shelf life (day)

The shelf life is a period of time which starts from harvesting and extends up to the start of rotting of fruits [10].

2.2 Chemical Analysis

2.2.1 Total soluble solids (TSS) and Tritrable acid (TA)

TSS was determined using a hand held refractometer, Atago, Japan and according to the methods of [11]. Samples of different chemically treated fruits were milled with 80 mL of distilled water. A drop of milled samples was placed on the refractometer prism, from which results were taken. Values of TSS taken were expressed as degree (°) Brix.Tritrable acid (TA) by treating against standard NaOH solution. All these chemical analysis methods were conducted according to [12].

2.3 Moisture Content

Moisture content of pepper expressed in percentage was determined by method described by AOAC 925.45 [13]. Empty crucibles were dried in an oven at 100°C for 30 min and weighed (W_1). A total of 10 g of pepper was placed in a crucible, accurately weighed and the combined weight recorded as (W_2). The crucible was kept in an oven at 100 to 105°C for 6 to 12 h until a constant weight was obtained. The oven dried sample were then placed in a dessicator and allowed to cool. The crucibles were weighed again after cooling (W_3).

2.4 Statistical Analysis

Mean and Standard Deviation were compared using analysis of variance, results were separated using Duncan multiple comparison test at significant levels of $p< 0.05$. (SPSS) version 12 software package.

3. RESULTS AND DISCUSSION

3.1 Physiological Weight loss (%)

At 7th day of storage period, treatment D pepper showed minimum weight loss (12.31%) followed by (16.39%) with treatment C both are statistically similar. On the other hand, treatment B showed highest percentage of (88.7%) weight loss in Table 1.

3.2 Shelf Life (Day)

Pepper in treatment D in Table1 had the highest (14day) shelf life, because evaporative cooler created a modified atmosphere by increasing CO_2 and decreasing O_2. Chlorine treatment also

Table 1. Combined effect of chlorine and packaging on post-harvest life of pepper

Treatments	Shelf life (days)	% Weight loss			50 % Non-marketable		
		7	14	21	7	14	21
A	11de	15.2lde (22.10)	56.93a (34.73)	88.7ab (69.18)	14.49d (31.55)	75.6ab (49.8)	89.99cd (67.36)
B	11de	79.22ab (55.09)	50.00a (28.64)	100a (85.86)	69.05ab (50.93)	80.69a (65.86)	100a (85.73)
C	13bc	7.49ef (16.39)	40.67b (24.75)	86.34cd (71.17)	14.78e (37.78)	66.7bc (51.7)	84.l3bcd (69.26)
D	14b	4.9f (12.31)	18.24 (14.75)	80.16d (63.35)	10.31e (0.97)	60.0d (41.5)	79.96d (44.76)
Level of Significance	**	*	*	*	*	*	**
CV (%)	**3.5**	**14.04**	**10.12**	**7.37**	**18**	**14.21**	**8.28**

Means with the same letter are not significantly different at 5% level by DMRT, Figures in parthesis indicate the transform value of the original

Keys: **= Significant at 5% level, **= significant at 1% level. sample A= no treatment and evaporative cooler basket; B = no treatment; sample C = chlorine treatment and basket; sample D = chlorine treatment and evaporative cooler basket*

reduced the microbial load and thus extends shelf life. On the other hand, non-treated with chlorine pepper showed the minimum (11 days) shelf life.

3.3 Marketability (50 %)

At 7 days of storage period, pepper in treatment D showed the minimum (0.97%) non-marketable fruits followed by 31% shown in treatment A. At 21 days of storage period, among all treatments, only pepper in treatment D had 44.76% marketability. In all other treatments, more than 67% pepper fruits were non-marketable at the same time.

The analysis showed that treatments differed in its effect on quality parameters among various samples examined. The observed trend of other samples may be related to water vapour accumulation within the polyethylene in foam in plastic basket (evaporative cooler) during storage. This was as a result of the reduction in O_2 content and an increase in CO_2 content leading to the accumulation of water vapour. Sample D showed reduced PWL compared to the unpacked samples. This result agrees with the findings of [14] who determined the effects of preharvest treatment, disinfections, packaging and storage environment on quality of pepper. The introduction of chlorine in the packaged fruits contributed to reduction in weight loss. Potassium permanganate is said to be an ethylene degrading chemical which degrades ethylene into water and carbon dioxide. Water accumulated within the packaging materials creating a high humid environment thereby retarding transpiration and water loss [15].

3.4 Moisture Content

It was observed that moisture content of the pepper samples gave 87.70%-89.20% in Table 2, similar finding reported that, water comprises about 80 to 90% of the fresh weight of pepper fruit with the size of the fruit influenced by availability of water to the plant [16]. From all treatments it was observed that moisture content decreases as the day increases. At 21 days, treatment D gave highest value of 81.50% moisture content.

3.5 Total Soluble Solids (TSS)

In fruits, conversion of starch to sugar is an important index of ripening [17]. TSS for sample A in Table 2 was the highest among all four samples examined. This was due to increase in ripening of sample A as a result of no treatment. As reported by [18], samples A gave higher TSS values of between 3.30 and 2.70°Brix. Higher TSS values are attributed to the absence of chemical treatment in the samples used for the study as compared to TSS values obtained from samples treated with chlorine. Samples C and D showed low Brix values of 1.40 and 1.30 on day 14 of storage while sample A recorded a significantly high Brix value of 3.30 on days 7 of

Table 2. Effect of treatment on moisture content, TSS and TA

Properties	Day	Sample			
		A	B	C	D
Moisture content (%)	1	89.20 ± 0.40[a]	88.50 ± 0.22[a]	88.30 ± 0.03[a]	87.70 ± 0.6[ab]
	7	88.70 ± 0.09[a]	85.80 ± 0.09[a]	83.70 ± 0.01[bc]	86.30 ± 0.19[ab]
	14	84.65 ± 0.15[ab]	80.60 ± 0.02[c]	80.93 ± 0.01[bc]	83.00 ± 0.66[bc]
	21	76.50 ± 0.01[bc]	80.20 ± 0.15[c]	80.90 ± 0.84[b]	81.50 ± 0.20[c]
TSS (^{o}Brix)	1	3.20 ± 0.01[ab]	2.40 ± 0.03[b]	2.62 ± 0.00[bc]	2.60 ± 0.04[a]
	7	3.30 ± 0.66[a]	1.85 ± 0.01[bc]	0.90 ± 0.00[d]	2.06 ± 0.10[b]
	14	3.10 ± 0.22[a]	1.40 ± 0.00[bc]	1.55 ± 0.01[b]	1.30 ± 0.00[b]
	21	2.50 ± 0.06[a]	2.70 ± 0.67[a]	2.00 ± 0.00[a]	2.15 ± 0.10[a]
TA	1	0.39 ± 0.07[b]	0.33 ± 0.03[b]	0.38 ± 0.02[b]	0.54 ± 0.02[a]
	7	0.49 ± 0.01[a]	0.28 ± 0.01[c]	0.19 ± 0.01[d]	0.42 ± 0.01[b]
	14	0.48 ± 0.07[a]	0.18 ± 0.04[b]	0.20 ± 0.05[b]	0.24 ± 0.04[b]
	21	0.49 ± 0.00[a]	0.51 ± 0.05[a]	0.50 ± 0.07[a]	0.50 ± 0.05[a]

Means in each row with the same alphabet are not significantly different (P>0.05) by Duncan multiple test. Values are means ± standard deviation (n = 3)

***Key:** TSS = total soluble solids; TA = tritrable acid ratio; sample A= no treatment and evaporative cooler basket; B = no treatment; sample C = chlorine treatment and basket; sample D = chlorine treatment and evaporative cooler basket*

storage. Result of this study agrees with the work of [19] who reported that H_3BO_3 reduces the rate of ethylene and CO_2 production in fruits thereby reducing the rate of respiration and ripening.

3.6 Tritrable Acid (TA)

From result in Table 2 (TA) was significantly highest on sample D on day 1 while samples A, B, and C gave highest numbers on day 21. TA increased on day 7 of storage for sample A and remained stable on days 14 and 21 of storage period compared to the treated samples B, C, and D that showed variations in their TA. TA is employed as ripening index for both tropical and subtropical fruits [20,21]. According to [22], TA value plays an important role in fruit taste which is a quality gauge in the processing of juice in the food and beverage industry. The sugar-acid ratio is also used as a better predictor of tomato taste as it involves the specific measurement of sucrose, fructose and glucose contents of the fruit [23,24]. Flavour characteristics of processed pepper products have also been reported to be influenced by the balance of sugar and acid contents in the fruit [25,18]. Sample D was significantly high ($p < 0.05$) on days 1 (0.54 ± 0.02) of storage period indicating higher percentage of sugar- acid when compared to other pepper samples.

4. CONCLUSION

Treated pepper samples stored in evaporative cooler were exhibited longer storage periods and showed higher quality. These treatments were able to keep the pepper fruits for 21 days without much spoilage and recorded little changes in their physicochemical properties. Chlorine treated sample showed high ripening rate compared to other treated fruits while samples A and D showed higher keeping quality. From results obtained from this study, it can therefore be concluded that, combination of chlorine treatment and evaporative cooler can ensure that pepper can be kept for 3 to 4 weeks.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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