

EFFECTS OF ORGANIC FERTILIZER, BAMBOO BIOCHAR RATES AND STORAGE MEDIA ON QUALITY OF RIPE TOMATO (*Lycopersicon esculentum* Mill) FRUITS

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ABSTRACT

Post-harvest loss of fruits in modern agriculture is of great importance due to the globalization of markets, which may involve transits over very long distances between producers and consumers. This study assessed the effects of storage media, nutrient sources, and tomato varieties on postharvest quality of tomato fruits. A $2 \times 4 \times 3$ factorial experiment in a Completely Randomized design was conducted using two varieties (Cobra F1 and Kerewa), four nutrient treatments, and three storage conditions, replicated three times. Results showed that evaporative cooling structures (block-in-block and charcoal) significantly improved moisture retention (0.08%, 0.16%) and enhanced lycopene (7.44%, 7.31%), vitamin A (45.35%, 44.36%) and vitamin C (14.59%, 13.28%) contents compared to open shelf storage (1.17%, 5.66%, 38.55%, 11.60%) respectively. Tomato fruits stored in charcoal cooling chamber had slightly higher moisture retention, while those stored in block-in-block better preserved lycopene, vitamin A and C. Cobra F1 fruits grown with biochar were superior in nutritional quality, whereas “kerewa” fruits had higher moisture content. Therefore, tomato fruits grown with biochar and stored in block-in-block and charcoal cooling chamber retains its quality.

Keywords: *Organic fertilizer, Bamboo biochar, Storage media, Tomato fruits*

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) is one of the most widely cultivated and extensively consumed horticultural crop (Abrar *et al.*, 2016). In Nigeria, it is one of the most important vegetable fruits grown for consumption in every home, consumed both fresh and in paste form and a cheap source of vitamin A, C, E and minerals which protect the body against diseases (Hosea *et al.*, 2017). A diet rich in tomato and its products is known to offer several health benefits which are attributed to their antioxidant content (Bhowmik *et al.*, 2012). Additionally, post-harvest losses in tomato value chain in Nigeria can reach up to 50%, there is limited access to finance from smallholder producers, and non-consistent quality standards for export (FAOSTAT, 2023). It is estimated that ripe tomato fruits contain approximately 94% water, 4.3% carbohydrates, 1% protein, 0.1% fat, 0.6% fibre and vitamins (Wogu and Ofuase, 2014). Deterioration of fresh tomato fruits can result from physiological breakdown due to ripening process, loss of water, injury, temperature or microorganism invasion (Bai *et al.*, 2021). Due to high perishable nature of

tomato fruits, many of them rot before they reached various areas of country where they are not cultivated and demand is high (Ahmed and Tariq, 2014).

The storage and preservation of tomato is vital to the economy of homes, farmers and country considering the important role played by tomato in health and food security (Irokanula *et al.*, 2015). Major challenges along tomato value chain in Nigeria had been identified to include deficiency in critical inputs such as lack of improved technology, low yield and productivity, high post-harvest losses, lack of processing and marketing infrastructure (Hosea *et al.*, 2017).

Many synthetics have been used to preserve tomato fruits but consumers are becoming very concerned on the use of synthetics on horticultural crops like tomato. The use of plant materials as preservatives apart from extending shelf life of foods, are less toxic to humans and animals than synthetic preservatives (Irokanula *et al.*, 2015).

Therefore, there is an urgent need to reduce the fruit quality losses and preserve its proximate contents through the use of appropriate nutrient

MATERIALS AND METHODS

The experiment was carried out at the Department of Horticulture laboratory, Federal University of Agriculture, Latitude 7° 10'N and longitude 3° 2' E, Abeokuta, Ogun state, Nigeria. The experimental design is a 2 x 4 x 6 factorial experiment conducted using a completely randomized design with three replicates. The factors were 2 tomato varieties [Cobra F1 (Hybrid) and "Kerewa" (Local)]; 4 nutrient types [Organic Fertilizer at 2.5 tha⁻¹, Biochar at 2.5 tha⁻¹, Organic Fertilizer at 2.5 tha⁻¹ + Biochar at 2.5 tha⁻¹ and Control (No fertilizer)] and Storage Media [Block-in-Block Evaporative Coolant Structure, Charcoal Evaporative Coolant Structure and Ambient Condition (Open Shelf)]. Proximate and nutrient analysis of the samples were determined using the methods described by AOAC, (2023).

Moisture content

Edible portion (5g) of tomato fruit sample of the treatments were weighed accurately and put in Petri dishes of a known weight which was placed in an oven at 100°C for 3hrs after which the samples were removed and put in a desiccator to cool. After cooling, the samples were weighed and returned to the oven for 30minutes, cooled and the dry weight of the sample was taken accordingly. The percentage moisture content was calculated as follows:

$$\% \text{ Moisture content} = \frac{\text{Weight of moisture}}{\text{Weight of sample}} \times 100$$

Dry matter

This was determined by deducting the moisture content (%) from 100. The bulk of each sample was dried in a thick wide container in the oven. The sample was cooled in a desiccator and weighed accordingly.

Crude Protein Determination

Digestion process: 0.2g of sample was weighed out into digestion tube and 15cm³ of H₂SO₄ acid was added. The tube was swirled gently until the sample and the acid was thoroughly mixed. 5g of Kjeldahl catalyst mixture was added and the solution was heated curiously until it is clear. Temperature was raised and the solution was heated to boil for 2 hours after the solution is cleared. The solution was allowed to cool and was transferred into 100cm³ volumetric flask and diluted to volume to volume with distilled water

and mixed thoroughly.

Ash content

A crucible was dried for at least 2 hours at 100°C, cooled and its weight was recorded (W1). 5g of sample was weighed into the crucible (W2). The sample was transferred into a pre-heated muffle furnace at 600°C for 2 hours. The crucible was removed from furnace and allowed to cool in a desiccator and weighed (W3).

$$\% \text{ Ash (dry basis)} = \frac{W3 - W1}{W2 - W1} \times 100\%$$

Where: W1 = weight of empty crucible (g).

W2 = weight of crucible (g) + sample before ashing (g).

W3 = weight of crucible (g) + ash (g)

Total Soluble Solid

This was determined using the formula

$$\frac{\text{Final weight (g)} - \text{Initial weight (g)}}{1,000,000} \times \text{Sample Volume (ml)}$$

Determination of Vitamin A using spectrophotometric method based on UV Inactivation

Approximately 200μ was added to alcoholic KOH to all tubes including blanks and mixed well for 10- 20 minutes; tubes were placed in a water bath at approximately 55° – 60°C for 20 minutes. Samples were cooled at room temperature, retinol was extracted by vigorous mixing of each tube on the vortex for at least 30 seconds, after centrifuging for 5 minutes. Xylene-kerosene supernatant was withdrawn by means of a constriction micropipette and later transferred from the curvette to glass tubes for irradiation.

Calculation

$$\begin{aligned} \text{Retinol } (\mu\text{g/dl}) &= A^\circ (328) \\ &- A \times 637 \\ \text{Carotenes } (\mu\text{g/dl}) &= A^\circ \\ &(460) \times 480 \end{aligned}$$

Where A° = optical absorbance after ultraviolet irradiation

Determination of Ascorbic Acid (Vitamin C) Using DCPIP Dye

Diluted tomato juice of 5ml was pipetted into a boiling tube and 1 ml of glacial acetic acid was added and titrated with dye solution to a faint permanent pink colour. The titre (T) was recorded and the titration was repeated with 5ml of water for the blank (Bl) and 5ml of ascorbic acid stand solution (st) and vitamin C content of the test

sample was calculated using the relationship:
$$\text{Vitamin C Test (mg/100ml)} = \frac{(T - Bl)}{(st - Bl)} \times \text{Dilution factor}$$

Determination of Lycopene

$$\text{Lycopene content (\%)} = \frac{(\text{cis-lycopene} + \text{trans-lycopene})}{\text{Total carotenoids}} \times 100$$

Data Analysis

Data collected were analyzed using SAS package and subjected to ANOVA at 5% level of probability to test for the significance. The initial and final means of the data obtained from the storage media will be compared using t-test.

RESULTS AND DISCUSSION

Effect of variety, fertilizer type and botanical on moisture content (g/100g) of tomato in different storage media

There was significant difference in moisture content among treatments in different storage media (Table 1). Block-in-Block Evaporative Coolant Structure (BBECS) had the lowest mean moisture content increase (0.08%), indicating superior moisture preservation compared to the Open Shelf (OS) 1.17%. The Charcoal Evaporative Coolant Structure (CECS) and BBECS were not significantly different in retaining tomato moisture content when stored as compared in the OS. Cobra F1 tomato varieties grown with organic fertilizer (2.5 tha⁻¹) + biochar (2.5 tha⁻¹) and stored with powdered jatropha leaves retained its moisture content in all the storage media. Kerewa fruits grown without fertilizer and stored without botanicals in all the storage media had the highest moisture content (9.27%, 7.94%, 7.53%) while Cobra F1 grown with organic fertilizer (2.5 tha⁻¹) + biochar (2.5 tha⁻¹) stored with powdered jatropha leaves had the lowest (1.17%, 0.08%, 0.16%) in OS, BBECS and CECS respectively. This corroborate the research of [Bai et al., 2021](#), who reported that deterioration of fresh tomato fruits can result from physiological breakdown due to ripening process, loss of water, injury, temperature or microorganism invasion.

Effect of varieties, fertilizer type and botanical on vitamin A content (µg/100g) of tomato in different storage media

The vitamin A content in the treatments were significantly different in the storage media (Table 2). Tomato fruits grown with bamboo biochar (2.5 tha⁻¹) stored with powdered jatropha in

CECS and BBECS had the same higher percentage increase in vitamin A (41.36%) than those on open shelf (33.48%). BBECS and CECS were similar and significantly superior to the Open Shelf for preserving Vitamin A content in tomato fruits. It was also recorded that, Cobra F1 tomato varieties grown with organic fertilizer (2.5 tha⁻¹) + biochar (2.5 tha⁻¹) and stored with powdered jatropha leaves recorded the highest Vitamin A increase (45.35%) in the BBECS than those in CECS (44.36%) as compared with those in the Open Shelf (38.55%). Among all treatments, Cobra F1 fruits grown with organic fertilizer (2.5 tha⁻¹) + biochar (2.5 tha⁻¹) stored with powdered jatropha leaves had the highest percentage increase in vitamin A (45.35%, 44.36%, 38.55%) while Kerewa without fertilizer and powdered jatropha leaves had the lowest percentage increase in vitamin A (18.36%, 19.35%, 12.41%) in BBECS, CECS and open shelf respectively.

Effect of varieties, fertilizer type and botanical on vitamin C content (mg/100g) of tomato in different storage media

There was significant difference in vitamin C content among treatments in different storage media (Table 3). Tomato fruits stored in BBECS had the highest mean percentage increase in vitamin C (9.38%), followed closely by those in CECS (9.17%), while those on OS had the lowest percentage increase (6.60%). The wide variability in percent increases, ranges from 3.51% (KNJ on OS) to 14.59% (CBJn in BBECS), indicate that treatment efficacy depends strongly on the specific juice type and storage structure interaction, with some combinations achieving more than double the vitamin retention of others. This is in accordance with Irokanula *et al.*, 2015 who reported that BBECS is the most effective storage medium for preserving/enhancing vitamin C content.

Effect of varieties, fertilizer type and botanical on lycopene content (mg/100g) of tomato in different storage media

Tomato fruits stored in BBECS produced the highest mean percent increase in lycopene (7.44%), followed by those in CECS (7.31%), while those on OS yielded the lowest percentage increase (5.66%). The percent increase ranged widely from 1.60% (KNJ on OS) to 7.44% (COBJ in BBECS), with those kept on OS having the lowest minimum values (KBJn at 2.47% and KNJ at 1.60%). Low lycopene retention due to

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faster deterioration on OS which corroborates the findings of Hosea *et al.*, 2017.

Table1: Effect of varieties, fertilizer type and botanical on moisture content (g/100g) of tomato in different storage media

COJ= Cobra F1 + organic fertilizer (2.5 tha⁻¹) + powdered jatropha leaves, COJn = Cobra F1 + organic fertilizer (2.5 tha⁻¹) Control (no botanical), CBJ = Cobra F1 + bamboo biochar (2.5 tha⁻¹)

Treatment	Block-in-Block Evaporative coolant structure			Charcoal Evaporative coolant structure			Open Shelf		
	Initial	Final	% increase	Initial	Final	% increase	Initial	Final	% increase
COJ	94.11	95.64	1.53	94.11	96.45	2.34	94.11	96.15	2.04
COJn	94.11	95.11	1.00	94.11	97.37	3.26	94.11	97.17	3.06
CBJ	95.07	97.01	1.94	95.07	95.49	0.42	95.07	97.08	2.01
CBJn	95.07	95.82	0.75	95.07	96.66	1.59	95.07	99.09	4.02
COBJ	95.11	95.19	0.08	95.11	95.27	0.16	95.11	96.28	1.17
COBJn	95.11	96.27	1.16	95.11	96.47	1.36	95.11	97.92	2.81
CNJ	93.62	94.91	1.29	93.62	95.52	1.90	93.62	97.98	4.36
CNJn	93.62	95.49	1.87	93.62	95.71	2.09	93.62	97.54	3.92
KOJ	93.08	95.11	2.03	93.08	95.51	2.43	93.08	97.54	4.46
KOJn	93.08	95.05	1.97	93.08	96.58	3.50	93.08	97.36	4.28
KBJ	94.21	96.01	1.80	94.21	95.63	1.42	94.21	99.09	4.88
KBJn	94.21	96.06	1.85	94.21	96.31	2.10	94.21	98.53	4.32
KOBJ	95.88	99.03	3.15	95.88	97.57	1.69	95.88	97.88	2.00
KOBJn	95.88	96.57	0.69	95.88	97.15	1.27	95.88	97.44	1.56
KNJ	87.76	92.39	4.63	87.76	91.25	3.49	87.76	96.89	9.13
KNJn	87.76	95.70	7.94	87.76	95.29	7.53	87.76	97.03	9.27
t-value	16.34								

+ jatropha, CBJn = Cobra F1 + bamboo biochar (2.5 tha⁻¹) Control (no botanical), COBJ = Cobra F1 + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) + jatropha, COBJn Cobra F1 + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) Control (no botanical), CNJ= Cobra F1 Control (no fertilizer) + jatropha, CNJn= Cobra F1 Control (no fertilizer & botanical), KOJ= Kerewa+ organic fertilizer (2.5 tha⁻¹) + powdered jatropha leaves, KOJn = Kerewa + organic fertilizer (2.5 tha⁻¹) Control (no botanical), KBJ = Kerewa + bamboo biochar (2.5 tha⁻¹) + jatropha, KBJn = Kerewa + bamboo biochar (2.5 tha⁻¹) Control (no botanical), KOBJ = Kerewa + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) + jatropha, KOBJn = Kerewa + organic fertilizer (2.5 tha⁻¹) Control (no botanical), KNJ= Kerewa Control (no fertilizer) + jatropha, KNJn= Kerewa Control (no fertilizer & botanical)

Table 2: Effect of varieties, fertilizer type and botanical on vitamin A content (µg/100g) of tomato in different storage media

COJ= Cobra F1 + organic fertilizer (2.5 tha⁻¹) + powdered jatropha leaves, COJn = Cobra F1 + organic fertilizer (2.5 tha⁻¹) Control (no botanical), CBJ = Cobra F1 + bamboo biochar (2.5 tha⁻¹) + jatropha, CBJn = Cobra F1 + bamboo biochar (2.5 tha⁻¹) Control (no botanical), COBJ = Cobra F1 + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) + jatropha, COBJn = Cobra F1 + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) Control (no botanical), CNJ= Cobra F1 Control (no fertilizer) + jatropha, CNJn= Cobra F1 Control (no fertilizer & botanical), KOJ= Kerewa+ organic fertilizer (2.5 tha⁻¹) + powdered jatropha leaves, KOJn = Kerewa + organic fertilizer (2.5 tha⁻¹) Control (no botanical), KBJ = Kerewa + bamboo biochar (2.5 tha⁻¹) + jatropha, KBJn = Kerewa + bamboo biochar (2.5 tha⁻¹) Control (no botanical), KOBJ = Kerewa + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) + jatropha, KOBJn = Kerewa + organic fertilizer (2.5 tha⁻¹) Control (no botanical), KNJ= Kerewa Control (no fertilizer) + jatropha, KNJn= Kerewa Control (no fertilizer & botanical)

Treatment	Block-in-Block Evaporative coolant structure			Charcoal Evaporative coolant structure			Open Shelf		
	Initial	Final	% increase	Initial	Final	% increase	Initial	Final	% increase
COJ	78.38	119.08	40.70	74.91	115.81	40.90	67.03	98.73	31.70
COJn	79.07	118.42	39.35	78.73	117.09	38.35	59.85	90.09	30.24
CBJ	69.73	111.09	41.36	79.75	121.11	41.36	66.58	100.06	33.48
CBJn	74.11	106.46	32.35	77.26	110.61	33.35	64.43	94.79	30.36
COBJ	75.64	120.99	45.35	85.60	129.96	44.36	68.39	106.93	38.55
COBJn	82.51	119.87	37.36	83.62	121.98	38.36	71.98	106.33	34.35

CNJ	76.44	111.79	35.35	73.97	108.33	34.35	69.79	100.14	30.36
CNJn	66.96	99.31	32.36	66.68	98.07	31.39	62.56	91.91	29.36
KOJ	66.33	102.68	36.35	66.82	103.94	37.12	60.29	92.02	31.73
KOJn	71.74	104.09	32.36	71.68	103.04	31.36	62.43	92.18	29.75
KBJ	79.26	108.61	29.35	76.39	106.75	30.36	66.89	94.03	27.14
KBJn	75.75	104.11	28.36	75.83	103.18	27.35	64.35	93.07	28.71
KOBJ	83.59	115.94	32.35	89.89	120.25	30.36	66.42	91.33	24.90
KOBJn	72.87	103.22	30.36	72.13	101.98	29.85	66.36	89.37	23.02
KNJ	74.81	97.16	22.36	77.37	100.72	23.35	66.08	86.24	20.17
KNJn	84.43	102.78	18.36	80.04	99.40	18.36	66.74	79.16	12.41
t-value	31.77								

Mochar (2.5 tha⁻¹) Control (no botanical), COBJ = Cobra F1 + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) + jatropha, COBJn Cobra F1 + organic fertilizer (2.5 tha⁻¹) Control (no botanical), CNJ= Cobra F1 Control (no fertilizer) + jatropha, CNJn= Cobra F1 Control (no fertilizer & botanical), KOJ= Kerewa+ organic fertilizer (2.5 tha⁻¹) + powdered jatropha leaves, KOJn = Kerewa + organic fertilizer (2.5 tha⁻¹) Control (no botanical), KBJ = Kerewa + bamboo biochar (2.5 tha⁻¹) + jatropha, KBJn = Kerewa + bamboo biochar (2.5 tha⁻¹) Control (no botanical), KOBJ = Kerewa + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) + jatropha, KOBJn = Kerewa + organic fertilizer (2.5 tha⁻¹) Control (no botanical), KNJ= Kerewa Control (no fertilizer) + jatropha, KNJn= Kerewa Control (no fertilizer & botanical)

Table 3: Effect of varieties, fertilizer type and botanical on vitamin C content (mg/100g) of tomato in different storage media

Table 3: Effect of varieties, fertilizer type and botanical on vitamin C content (mg/100g) of tomato in different storage media

Treatment	Block-in-Block Evaporative coolant structure			Charcoal Evaporative coolant structure			Open Shelf		
	Initial	Final	% increase	Initial	Final	% increase	Initial	Final	% increase
COJ	15.64	27.81	12.17	14.55	27.00	12.45	11.14	21.08	9.94
COJn	14.24	24.95	10.71	12.70	22.81	10.11	9.85	18.66	8.81
CBJ	14.02	24.41	10.39	15.66	25.15	9.49	10.13	16.36	6.23
CBJn	14.22	28.80	14.59	14.81	28.09	13.28	12.43	24.03	11.60
COBJ	19.21	30.10	10.89	19.38	30.09	10.71	13.85	20.97	7.12
COBJn	15.53	25.04	9.51	12.11	20.93	8.83	10.19	17.03	6.85
CNJ	14.25	23.76	9.51	13.29	22.10	8.81	9.53	16.17	6.64
CNJn	16.68	25.20	8.52	16.30	24.96	8.66	10.87	17.03	6.16
KOJ	13.58	22.04	8.46	14.40	23.67	9.27	9.20	15.07	5.86
KOJn	17.96	26.17	8.20	17.92	26.53	8.62	12.71	17.99	5.28
KBJ	17.17	25.97	8.79	17.41	26.22	8.81	12.76	18.26	5.50
KBJn	20.07	28.74	8.66	20.04	28.13	8.09	14.16	19.61	5.45
KOBJ	19.91	26.77	6.86	19.82	27.03	7.21	13.39	18.63	5.24
KOBJn	15.30	23.17	7.87	14.67	21.99	7.32	8.63	13.51	4.88
KNJ	15.53	21.31	5.78	14.93	20.93	6.00	9.98	14.67	4.69
KNJn	14.97	20.18	5.21	14.53	19.67	5.14	10.52	14.03	3.51
t-value	20.13								

COJ= Cobra F1 + organic fertilizer (2.5 tha⁻¹) + powdered jatropha leaves, COJn = Cobra F1 + organic fertilizer (2.5 tha⁻¹) Control (no botanical), CBJ = Cobra F1 + bamboo biochar (2.5 tha⁻¹) + jatropha, CBJn = Cobra F1 + bamboo biochar (2.5 tha⁻¹) Control (no botanical), COBJ = Cobra F1 + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) + jatropha, COBJn = Cobra F1 + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) Control (no botanical), CNJ= Cobra F1 Control (no fertilizer) + jatropha, CNJn= Cobra F1 Control (no fertilizer & botanical), KOJ= Kerewa+ organic fertilizer (2.5 tha⁻¹) + powdered jatropha leaves, KOJn = Kerewa + organic fertilizer (2.5 tha⁻¹) Control (no botanical), KBJ = Kerewa + bamboo biochar (2.5 tha⁻¹) + jatropha, KBJn = Kerewa + bamboo biochar (2.5 tha⁻¹) Control (no botanical), KOBJ = Kerewa + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) + jatropha, KOBJn = Kerewa + organic fertilizer (2.5 tha⁻¹) Control (no botanical), KNJ= Kerewa Control (no fertilizer) + jatropha, KNJn= Kerewa Control (no fertilizer & botanical)

Table 4: Effect of varieties, fertilizer type and botanical on lycopene content (mg/100g) of tomato in different storage media

Treatment	Block-in-Block Evaporative coolant structure			Charcoal Evaporative coolant structure			Open Shelf		
	Initial	Final	% increase	Initial	Final	% increase	Initial	Final	% increase
COJ	8.63	14.70	6.07	8.11	14.12	6.02	6.19	12.27	6.07
COJn	8.03	14.22	6.19	7.10	13.28	6.18	5.41	11.23	5.82
CBJ	6.62	12.05	5.44	8.16	12.97	4.80	5.79	11.47	5.68
CBJn	7.92	14.58	6.66	8.85	15.60	6.75	4.51	9.10	4.59
COBJ	9.59	17.03	7.44	8.72	16.03	7.31	6.74	12.40	5.66
COBJn	9.84	15.02	5.18	9.36	14.50	5.14	6.13	10.72	4.59
CNJ	6.41	10.71	4.30	7.68	12.03	4.36	5.99	10.17	4.18
CNJn	6.32	10.50	4.17	7.01	11.10	4.09	4.41	8.25	3.84
KOJ	7.56	12.23	4.68	6.98	11.36	4.38	4.41	8.01	3.60
KOJn	7.38	12.11	4.73	7.22	11.97	4.75	4.65	8.43	3.79
KBJ	9.20	13.36	4.16	7.79	11.94	4.15	4.84	7.65	2.81
KBJn	8.24	12.53	4.30	8.16	12.57	4.41	5.33	7.80	2.47
KOBJ	9.79	14.17	4.38	9.28	13.70	4.42	5.36	9.07	3.71
KOBJn	8.10	11.99	3.89	7.61	10.99	3.38	5.36	7.83	2.47

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KNJ	6.42	9.08	2.66	6.87	9.35	2.49	5.42	7.02	1.60
KNJn	6.56	10.16	3.60	7.33	10.09	2.76	6.24	8.01	1.77
t-value	13.60								

COJ= Cobra F1 + organic fertilizer (2.5 tha⁻¹) + powdered jatropa leaves, **COJn**= Cobra F1 + organic fertilizer (2.5 tha⁻¹) Control (no botanical), **CBJ**= Cobra F1 + bamboo biochar (2.5 tha⁻¹) + jatropa, **CBJn**= Cobra F1 + bamboo biochar (2.5 tha⁻¹) Control (no botanical), **COBJ**= Cobra F1 + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) + jatropa, **COBJn** Cobra F1 + organic fertilizer (2.5 tha⁻¹) Control (no botanical), **CNJ**= Cobra F1 Control (no fertilizer) + jatropa, **CNJn**= Cobra F1 Control (no fertilizer & botanical), **KOJ**= Kerewa + organic fertilizer (2.5 tha⁻¹) + powdered jatropa leaves, **KOJn**= Kerewa + organic fertilizer (2.5 tha⁻¹) Control (no botanical), **KBJ**= Kerewa + bamboo biochar (2.5 tha⁻¹) + jatropa, **KBJn**= Kerewa + bamboo biochar (2.5 tha⁻¹) Control (no botanical), **KOBJ**= Kerewa + organic fertilizer (2.5 tha⁻¹) + bamboo biochar (2.5 tha⁻¹) + jatropa, **KOBJn**= Kerewa + organic fertilizer (2.5 tha⁻¹) Control (no botanical), **KNJ**= Kerewa Control (no fertilizer) + jatropa, **KNJn**= Kerewa Control (no fertilizer & botanical)

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CONCLUSION

This study established that Evaporative coolant structures (Block in Block and Charcoal) help retain and enhance moisture, lycopene, vitamins A and C content in tomato better than open shelf storage. Cobra F1 variety grown with bamboo biochar stored with or without powdered jatropa leaves preserves or retain moisture, influences lycopene accumulation, vitamins A and C contents than kerewa variety.

RECOMMENDATION

It is recommended that farmers adopt evaporative cooling structures, particularly charcoal-based systems, and cultivate Cobra F1 with bamboo biochar to enhance tomato quality and nutrient retention during storage.

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