Effect of Potassium Permanganate on Colour and Textural Characteristics of Tomatoes at Ambient Temperature Storage

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ABSTRACT

Mature unripe tomato fruits were evaluated to check the effectiveness of potassium permanganate on the quality parameters of colour and texture under ambient storage conditions in extending the shelf life of tomatoes. 50 g each of mature unripe tomato fruits were weighed into a plastic container containing different concentrations of potassium permanganate including control (2.5 ppm, 5.0 ppm, 7.5 ppm, 10.0 ppm, 12.5 ppm and 15.0 ppm). The experiment was laid out in a complete randomized design and replicated four times. A sensory evaluation of quality parameters of color and texture was carried out using a hedonic scale ranking.

Results obtained were analyzed using analysis of variance and Least Significant Difference (LSD). Under ambient conditions, the tomatoes samples that were stored with a concentration of 5 ppm of KMnO_4 showed a higher or acceptable quality in terms of colour and texture.

In terms of shelf life, 7.5 ppm of KMnO_4 under ambient conditions, kept the tomatoes in an acceptable quality for 11 days as shown in the result.

Keywords: Tomatoes preservation, Sensory evaluation.

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I. INTRODUCTION

Tomatoes constitute one of the major vegetables cultivated in Nigeria, with an annual output of 1.8 m tonnes but over 50% of these are lost due to poor storage and post-harvest handling methods, poor transportation, and lack of processing methods [1]. These have caused considerable loss in income to farmers and distribution agents. The fruit is rich in lycopene and is consumed in both fresh and paste form to provide the much-needed vitamins and minerals in diets. Tomatoes are not only seasonal but highly perishable and deteriorate a few days after harvest. Post-harvest losses contribute significantly to food scarcity in African and most developing countries. Bourne [2] reported that post-harvest losses in tomatoes can be categorised into Biological, Micro biological, Chemical and biochemical as well as mechanical/physical damage. Consequently, evolving measures to combat food losses arising from poor handling and storage conditions constitute one channel of enhancing food availability.

Different preservation methods have been employed in extending the shelf life of tomatoes after harvest, which involves the manipulation of the storage environment, alteration of the physical composition through processing or the addition of a preservative [3].

Tomato is a climacteric fruit, having respiratory peaks during its ripening process. The ripening of fruits represents the unique co-ordination of developmental and biochemical pathways leading to changes in colour, texture, aroma, and

nutritional quality of mature seed-bearing plant organs. The gaseous plant hormone ethylene plays key regulatory role in ripening programmes but there are common characteristics associated with ripening process such as changes in colour, altered sugar metabolism, fruits softening and alterations in texture, the synthesis of aroma volatiles and an increased susceptibility to pathogen infection [4], [5].

Potassium permanganate have been reported [6] to exhibit the capacity to remove exogenous ethylene from the atmosphere which play a major role in fruit ripening. The mechanism of action involves the absorption and oxidation of ethylene to carbon dioxide and water, thus increasing the concentration of carbon dioxide and blocking the synthesis of endogenous ethylene which is essential for the control of ripening.

The textures of fruits have a considerable effect on consumer perception of the quality. Different factors affect fruit textural properties among them are cell wall polysaccharide composition [7], although cell wall enzymes activities change during growth and ripening. Softening is a developmentally programmed ripening process associated with biochemical changes in cell wall fractions involving hydrolytic processes resulting in breakdown of cell wall polymers such as cellulose, hemicelluloses and pectin. Such hydrolytic reactions are brought about by polygalacturonase, pectin methylesterase, β -galacturonase. Investigations have shown that textural changes during ripening have contributed significantly to determining the shelf life of a fruit [8]. Tomato is highly perishable, and several problems are encountered in harvesting, transportation, storage, and

marketing resulting in huge losses. There has been an increased production of tomatoes to some extent, the purpose of obtaining maximum profit will be served only if the increased production will be supplemented with similar efforts to minimise post-harvest losses and enhance shelf life [9].

Various efforts have been made in the use of certain chemicals and plant hormones to delay ripening and reduce losses thereby improving and maintaining colour and quality by slowing down metabolic activities of the fruits [10]. Some chemicals such as potassium permanganate have been shown to remove exogenous ethylene from the atmosphere, which played a central role in tomato fruit ripening by absorbing and oxidising it to carbon dioxide and water [11], [12], thus increasing the concentration of carbon dioxide and blocked the synthesis of endogenous ethylene.

Investigations carried out have revealed [13] that Potassium permanganate have been shown to extend the shelf life of non-climacteric agricultural produce by extending the shelf life, retarding the loss of green colour and microbial wastage of lemon, and lettuce while inhibiting rotting of straw berry. The objective of this study is to determine the effectiveness and concentration of potassium permanganate that will extent the shelf life and affect product sensory quality of tomatoes under ambient condition of storage.

II. MATERIALS AND METHODS

Materials used were, mature unripe tomatoes fruits, mettler top weighing balance, plastic transparent container, aerated pouches, potassium permanganate solution of different concentrations, methylated spirit, cotton wool, a pair of scissors, masking tapes, cotton mesh- sealing. 50 g each of mature unripe tomatoes fruit were washed, rinsed, and weighed with mettler top weighing balance. The tomatoes were then transferred to a plastic transparent container which have been washed, rinsed, and cleaned with

methylated spirit. The experiment was carried out using the complete randomized design with seven treatment and four replicates.

Different concentrations of potassium permanganate were prepared (control, 2.5 ppm, 5.0 ppm, 7.5 ppm, 10.0 ppm, 12.5 ppm, 15.0 ppm) and soaked in cotton absorbers, then put inside aerated pouches and transferred into the plastic containers. The plastic transparent containers containing the mature unripe tomatoes, and the aerated pouches of potassium permanganate is then sealed with a mesh to prevent contamination or pollution. The samples were then kept at room temperature (ambient) 27-30 °C the rate of ripening of the tomatoes fruit is monitored on a daily basis. A hedonic scale ranking is carried out to determine the degree of colour change and acceptability: the same procedure is carried out to determine the texture or degree of softeners of the fruit.

Data collected daily for colour in ambient condition using the hedonic scale ranking system of 1-5 where:

1. Fresh (Very Green)
2. Good (Green)
3. Half ripe (Pink)
4. Ripe (Red)
5. Bad

Data were also collected daily for texture under ambient condition and the data was analysed using analysis of variance and LSD. The data collected was subjected to hedonic scale ranking of 1-6 where:

1. Hard;
2. Fairly hard;
3. Medium;
4. Fairly soft;
5. Soft;
6. Bad.

III. RESULTS

TABLE I: EFFECT OF KMnO_4 ON THE COLOUR OF TOMATOES UNDER AMBIENT TEMPERATURE

Day	Controls	2.5 ppm	5 ppm	7.5 ppm	10 ppm	12.5 ppm	15 ppm
1	2.00	1.25	1.00	1.25	1.50	1.00	1.50
2	2.75	1.50	1.00	1.50	2.25	2.00	2.75
3	3.00	1.50	1.00	2.00	2.50	2.50	3.00
4	3.25	2.00	1.50	2.25	2.50	3.00	4.25
5	3.75	2.50	2.00	2.50	2.75	3.25	4.25
6	4.00	3.00	3.25	3.00	3.50	3.75	4.25
7	4.00	3.25	3.25	3.00	3.50	3.75	4.25
8	4.75	3.50	3.50	3.25	4.00	4.00	4.25
9	5.00	3.75	4.00	3.75	4.00	4.00	4.25
10	5.00	3.75	4.00	3.75	4.00	4.00	4.50
11	5.00	4.25	4.25	4.00	4.25	4.00	4.50
Mean	3.86	2.75	2.61	2.66	3.16	3.21	3.79

TABLE II: EFFECT OF KMnO_4 ON THE TEXTURE OF TOMATOES UNDER AMBIENT TEMPERATURE

Day	Controls	2.5 ppm	5 ppm	7.5 ppm	10 ppm	12.5 ppm	15 ppm
1	1.25	1.00	1.25	1.25	1.00	1.25	1.25
2	2.50	1.75	1.50	1.25	2.75	2.00	2.25
3	3.75	2.00	1.75	2.25	3.00	3.50	3.50
4	4.00	2.50	2.25	2.50	3.00	4.00	5.50
5	4.25	2.75	2.50	3.00	3.50	4.75	5.50
6	5.00	3.25	3.50	3.50	4.25	4.75	5.50
7	5.00	3.75	3.50	4.00	4.50	5.00	5.50
8	5.75	4.25	4.00	4.00	5.00	5.00	5.75
9	6.00	4.50	4.50	4.75	5.00	5.00	6.00
10	6.00	4.75	4.75	4.75	5.25	5.00	6.00
11	6.00	5.25	5.25	5.00	5.25	5.00	6.50
Mean	4.50	3.25	3.14	3.30	3.77	4.09	4.84

TABLE III: THE MEAN OF THE EFFECT OF DAYS ON COLOUR AND TEXTURE IN AMBIENT CONDITION

Day	Colour (ambient)	Texture (ambient)
1	1.4286 ^a	1.2143 ⁱ
2	1.9643 ^f	1.8571 ^h
4	2.2500 ^f	2.8214 ^b
5	2.6786 ^e	3.3929 ^f
6	3.0714 ^d	3.7500 ^e
7	3.5357 ^c	4.2500 ^d
8	3.5710 ^c	4.5357 ^{cd}
9	3.8929 ^{bc}	5.1071 ^{bc}
10	4.1071 ^{ab}	5.2143 ^{ba}
11	4.1429 ^a	5.3214 ^a
LSD	0.3736	0.3194

Table III shows the day mean of color and texture in ambient conditions. There was significant higher ($p \leq 0.05$) mean color changes as the day progresses. Day 11 (ambient) was recorded to have the worse color changes though did not differ statistically from day 9 and 10 (ambient.) This also coincides with texture at ambient conditions, which shows that as the color changes, so does the texture of the tomato.

IV. DISCUSSION

The study has shown that both the treated and integrated tomato went through different stages of ripening. It also shows that the potassium permanganate has a preservative effect on tomato.

Furthermore, the concentration of the chemical used has an effect on the quality parameters of color and texture examined. This result agrees with those reported by some researchers [10] who reported that certain chemicals are known to delay ripening, reduce losses and maintain the color and quality by reducing the rate of metabolic activity. Texture played an important role in consumer acceptability of tomato fruit. Texture is an important attribute to evaluate the quality of tomato fruit and it is determined by the fruit morphological and physiological characteristics, epicarp firmness and maturity stage [14], the study however, showed that the textural scores increase with the passage of ripening.

Under ambient conditions 5.0 ppm was known to perform better in terms of texture and color, although did not differ statistically ($p \leq 0.05$) from concentrations 2.5 ppm and 7.5 ppm, compared to control which had a relatively significant difference and showed a higher rate of color change (ripening) and textural deterioration. The result obtained seem to be in agreement with those reported by [14] that the texture scores increase with the passage of ripening stages in tomato fruits.

The study also indicate that potassium permanganate is effective at lower concentrations in delaying ripening of fruits, extending shelf life and improving textural quality under ambient conditions (26-28 °C). The results obtained were in agreement with those reported by [15] who investigated colour changes in pawpaw fruits preserved with potassium permanganate. It was shown that treatment of the fruits with potassium permanganate extended the shelf life and gave firm textural quality to the fruits. Also, delay in ripening process and extension of shelf life of mango fruits

have been reported [16] while some authors [17] affirmed the potential of potassium permanganate as a preservative in tomatoes at 400 ppm concentration level. The study shows that the delayed ripening process confirms the capacity of potassium permanganate to extend shelf life of tomatoes at ambient temperature. Wabali [18] have reported shelf life extension of refrigerated tomatoes treated with various concentrations of potassium permanganate.

Similarly, the effectiveness of potassium permanganate in maintaining fruit firmness and vigor as well as other sensory characteristics have been confirmed by some scholars working on pears [19].

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