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# Effects of NSPRI wall-in-wall evaporative coolant on physical properties of stored tomato

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## Abstract

Nigerian Stored Products Research Institute developed a wall-in-wall evaporative cooling system for the storage of fresh fruits and vegetables. This is an effort in mitigating post-harvest loss of fruits and vegetables. The effect of the cooling system on the physical properties of tomatoes was investigated using ambient shelf storage as a control. Weight loss, firmness loss and colour changes of tomatoes were the major physical properties studied. Tomatoes were stored for 24 days. There was significantly higher loss in weight of tomatoes stored in ambient (68%) than those of the evaporative coolant (32%). There was significant higher loss in firmness of the tomato stored in ambient (95%) those in evaporative cooling system (58%). Tomatoes stored in evaporative cooling system retained better color while those under ambient became darkened at the end of the storage period.

**Keywords:** Evaporative coolant; Tomatoes; Weight loss; Color; Firmness

## 1. Introduction

Fruits and vegetables are important agricultural products grown majorly in the northern part of Nigeria (Ibidapo *et al.,* 2017). They have high nutritional and medical values. They are rich sources of antioxidants, enzymes, minerals and vitamins, like thiamine, riboflavin, vitamin B-complex (Yuanjuan *et al.,* 2015). Antioxidant contents of fruits and vegetables especially carotenoids may be beneficial in preventing major health problems such as blindness, cancer, and cardiovascular/coronary heart diseases due to their antioxidant activity (Yeum & Russell, 2002; Yogesh *et al.,* 2015). Several researches and field observations had reported that 40–50 % of agricultural fruits and vegetables produced in developing countries are lost before they can be consumed (Kamaldeen et al., 2019). This lost had been linked to improper postharvest handling and lack of suitable storage facility. Fresh fruits and vegetables are better stored under low temperatures. As a major stakeholder in mitigating postharvest loss in fruits and vegetables, NSPRI had developed Evaporative coolants of different types and sizes for the storage of fresh fruits and vegetables. 5 tons metal-in-wall evaporative coolant was recently constructed in NSPRI Kano. The aim of this study is to evaluate effectiveness of the coolant.

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## 2. Material and methods

### 2.1. Sample Preparation

Tomatoes (UTC variety) were purchased from Yankaba market Kano, Nigeria. The tomatoes were sorted then washed using clean water and then arranged for storage using NSPRI evaporative coolant. The selection of the tomatoes was based on similar color and firmness as measured prior to storage. 10 each of the fruits was selected and labelled for the changes in physical properties. The remaining fruits were kept in the create and stored in the coolant. Each ten labelled sample was investigated for physical properties (weight loss, color change and firmness) every four days i.e. 0, 4, 8, 12, 16, 20, and 24 days.

### 2.2. Determination of physical qualities

Physical qualities such as weight loss, firmness and color change were determined during the storage period. Weight loss was determined using the digital weighing balance, firmness of the fruits was measured using the durometer while color change was determined using the color meter. Bulk weight of the fruits was measured using spring balance.

## 3. Results and discussion

### 3.1. Effects of the Coolant on the Physical Properties of the Stored Tomatoes

#### *3.1.1. Weight Loss*

Results from the effects of the NSPRI evaporative coolant are shown in Table 1: The results showed that there is significant difference (≤ 0.05) in weight loss of the tomatoes. The tomatoes stored in the coolant had significant low weight loss as compared with those stored under ambient condition. The reason could be as results of environment factors (temperature and humidity) difference within the two storage conditions. Environmental relative humidity was low (40 – 55%) during the experiment thereby making the fruits under ambient conditions release their moisture to the environment as a result leads to significant loss of weight. The fact here is that, there is very low interaction of the coolant with the environment thereby making it better for the storage purpose.

#### *3.1.2. Firmness Changes*

The results also showed that there is significant difference (≤ 0.05) in firmness of the tomatoes. The fruits stored in the evaporative coolant had significant low firmness loss as compared with those stored under ambient condition. The reason could as well be as a result of environment factors (temperature and humidity) difference within the two storage conditions. Environmental temperature was significantly higher (22 – 38 $^0$C) than that of the cold room (4 – 6 $^0$C) during the experiment. Higher temperature can lead to expansion and contraction within the fruits structures which as a result can lead to softening of the fruits. The fact here is that, there is very low interaction of the coolant with the environment temperature thereby making it better for the fruit storage purpose. Difference in biological composition in the fruits could be a reason for the difference firmness loss.

#### *3.1.3. Colour Changes*

The results showed that the tomatoes stored in the NSPRI coolant significantly retained (≤ 0.05) color compared with those under ambient conditions. The reason could be as a result of environment factors (temperature, humidity, light) difference within the two storage conditions. It can be seen from the results that the rate at which the values of color increases is drastic for the ambient storage compared with that of the coolant. Also the rate at which the values fall along the storage period is also drastic for ambient storage than those of evaporative coolant. This indicates significant environmental interaction with the color change of the fruits stored under ambient condition. Similar range of color values of tomatoes stored in the coolant indicates the ability of the cold room in retaining the color.

**Table 1** Effects of the Coolant on Physical Properties of the stored Tomatoes

| Storage Conditions | Physical properties | Storage period (days) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | 4 | 8 | 12 | 16 | 20 | 24 |
| ECS | Weight loss | 0.088±0.009 | 0.086±0.008 | 0.081±0.009 | 0.072±0.003 | 0.067±0.003 | 0.061±0.003 | 0.055±0.003 |
| Ambient storage | | 0.083±0.009 | 0.081±0.011 | 0.067±0.011 | 0.061±0.011 | 0.049±0.016 | 0.035±0.018 | 0.026±0.016 |
| ECS | Firmness | 0.363±0.016 | 0.301±0.016 | 0.273±0.025 | 0.109±0.025 | 0.082±0.025 | 0.056±0.024 | 0.055±0.024 |
| Ambient storage | | 0.384±0.016 | 0.276±0.025 | 0.149±0.023 | 0.056±0.024 | 0.015±2.553 | 0.001±0.037 | 0.000±0.026 |
| ECS | Colour Change | 52.22±4.57 | 90.21±5.48 | 95.19±5.48 | 98.33±5.48 | 96.13±5.48 | 81.43±4.52 | 89.79±4.52 |
| Ambient storage | | 49.36±3.91 | 81.66±4.52 | 96.40±5.48 | 101.58±5.16 | 112.19±5.37 | 40.81±3.21 | 57.48±4.57 |

Mean values of the weight loss with standard deviation

## 4. Conclusion

Effects of the NSPRI evaporative cooling system on the physical properties of stored tomatoes had been investigated. The wall-in-wall evaporative coolant significantly lowered the weight loss, loss in firmness and colour of the tomatoes better than those stored under ambient condition.

## Compliance with ethical standards

*Disclosure of conflict of interest*

No conflict of interest.

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