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Effect of Packing Materials on Shelf Life of Tomato (*Lycopersicon esculentum Mill*) Under Laboratory Condition

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Abstract: The experiment was done to study the effect of packing materials on the shelf life of tomatoes *(lycopersican esulentam*) under laboratory conditions of Hawassa University Agriculture College protection laboratory in 2020. To reduce post-harvest losses of tomato production the packing materials such as Nets, DPB, LTPB, and cartons were evaluated concerning their effect on the produce of shelf life of tomatoes under laboratory conditions. These studies were conducted for analysis of total weight losses, disease incidence and severity, firmness, pH value, TSS and TAA green matured tomatoes at 20°C laboratory conditions. In general, after 24 days of the storage period, the pH value of the tomato was high a significant difference within each other treatment, and the total weight losses were relatively different with the low temperature of storage condition. The disease incidence and severity closely occurred on the control with 100±2.5298%. The TSS and TAA DPB, LTPB treatment was found to be superior in retaining maximum TSS, titrable acidity, and ascorbic acid content of tomato fruits even up to the end of the storage period. The firmness measured by the newton of treatment five shows high superiority which recorded carton (743.33N ±60.590) when compared with control (130N ±60.590). The firmness values were decreased in all the samples stored in different conditions and with different packing materials.

Keywords: Packaging Materials, Firmness, Disease Incidence and Severity, Weight Loss

1. Introduction

1.1. Background and Justification

Tomato (Lycopersicon esculentum Mill.) is a member of the Solanaceae family which is famous for several medicinal, nutritional, and horticultural crops like egg-plant, potato tubers, and tomatoes, botanically this fruit is known as a berry [1]. Though it is a perennial crop some of its cultivars are grown as an annual crop in various parts of the world [2, 3]. It is the second most important vegetable crop next to potatoes [4]. Tomatoes are a popular food item in Ethiopia. High in water-soluble vitamins and minerals, dietary fiber, low in fat and calories, the main source of vitamins A, C, and lycopene, they are consumed daily in households. Tomato production is an important source of income for smallholder farmers. While domestic tomato production has intensified across the country in recent years, it still does not meet the high demand. This situation is attributed to some constraints in the production and marketing chain [5]. Post-harvest loss has been defined as a "measurable quantitative and qualitative loss of a given product at any moment along the postharvest chain" [6]. Change in the availability, edibility, wholesomeness or quality of the food that prevents it from being consumed" [7]. Postharvest loss does not equal food loss necessarily. Thus, the reduction of post-harvest losses of perishables is of major importance when striving for improved food security in developing countries [8]. Postharvest losses are often more significant than fresh fruit and vegetable losses that occur in the field. During storage, fruit and vegetables deteriorate through the action of spoilage microorganisms, which become activated because of the changing physiological state of the fruit and vegetables. The quality of fresh tomatoes is mainly determined by appearance (color, visual aspects), firmness, flavor, and nutritive value [9]. Consumers measure the quality of tomato fruit primarily by three factors: physical appearance (color, size, shape, defects, and decay), firmness, and flavor. Fruit quality is significantly affected by the stage of ripeness when removed from the plant, the number of times handled, and storage temperature and time. According to Saeed (2010) flavor, comprised of aroma, is an important food quality attribute. Another aspect of fruit flavor is fruit size; the smaller fruit is more flavorful as compared to the larger [10].

Tomato fruit kept within sealed packages resulted in an atmosphere with high CO2 and low O2 content. These conditions retained flesh firmness, low acidity and soluble solids concentration, and delayed fruit lycopene [11]. Among the various techniques developed to extend fruit postharvest life, the use of plastic film is growing in importance because it is convenient in the many different conditions throughout the chain of handling from producer to consumer. [12] Stated in their work that LDPE film is generally used for the packaging of fresh fruits and vegetables, owing to its high permeability and softness when compared to HDPE film. Polyethylene can be easily sealed, has good O2 and CO2 permeability, low-temperature durability, and good tear resistance, and is of a good appearance. Modified atmosphere packaging (MAP) using polymeric films is also a simple inexpensive method to extend the postharvest life of fresh fruits like tomatoes. Modified atmosphere packaging has been shown to delay ripening and extend the shelf life of tomato fruits [13]. Mathooko [14] reported that under tropical conditions, the quality and storage life of tomato fruits can be extended and ripening delayed by modified atmosphere packaging. Ait-Oubahou [15] developed a model for MAP of tomato fruits in the Horn of Africa where it was demonstrated that modified atmosphere conditions retained fruit flesh firmness, low acidity, soluble solid concentration, and delayed lycopene development in tomato fruits. Premature harvesting, poor storage facilities, lack of infrastructure, lack of processing facilities, and inadequate market facilities cause high food losses in developing countries along the entire Food Supply Chain (FSC)) [15]. So far, information about the effect of packaging material on the shelf life of tomato fruit is limited in our country's case. Therefore, considering this fact the research paper was conducted with the overall objective to evaluate the effect of packing materials on the shelf and quality of tomato.

1.2. Objective

To evaluate the effect of packing materials on the shelf life of tomatoes under laboratory condition.

2. Materials and Method

2.1. Description of the Study Area

The experiments were conducted at Hawassa University College of Agriculture under laboratory conditions. The site is located 273 Kilometers far from Addis Ababa and lies at 1708 meters above sea level (masl) and 38°46' E longitude and 07°05' N latitude [16]. Annual rainfall is 900-1100m with a temperature is 12°-27°C. The experiment will be carried out in the Agroforestry protection lab. With intervals of 20°C, 60% of temperature, and relative humidity respectively.

Treatments are layout with 5-treatment combination

Treatment 1 Control (no packing)

Treatment 2 Nets

Treatment 3 Dark Plastic Bags

Treatment 4 Light Transplant Plastic Bag

Treatment 5 Carton

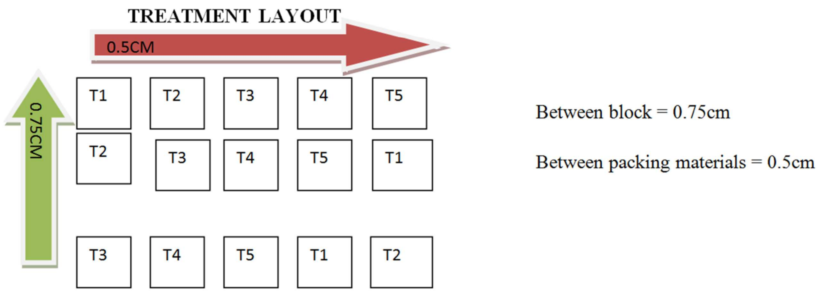

Figure 1 *Treatment settle.*

2.2. Experimental Materials, Design and Procedures

Matured tomato fruit was used as experimental material. The fruits be the same maturity level, equal size, the same weight, and good appearance were collected from the local market of Hawassa. Then each of the fruits was washed in pure water for five min to reduce field heat and sorted, graded, and packed in the clean packing materials separately within each of packing materials. Collected tomato fruit, five were randomly selected and put into the labeled packing materials for each treatment, and from the sample, three fruits were used for the experiment. A completely Randomized Design (CRD) design with three replications was used because the experiment was done under laboratory condition. The data was recorded in the three-day interval. Data was recorded for up to 24 days starting from the first day of storage. Then after the final day recodes the result was used for statistical analysis.

2.3. Treatment

Treatments consisted of five packaging materials-cartons, nets, dark plastic bags (DPB), light transplant plastic bag (LTPB), and control (none packaged) with a tomato room temperature of 20°C and 60%, relative humidity the recommended Tomato storage at MAP extended for 24days from relatively different packing materials Nigerian Stored Product Research for transporting tomato in Nigeria [16].

2.4. Data to Be Collected

2.4.1. Physical Quality Measurements

i). *Disease (Incidence decay*): The measurements analysis of fruit packed under different packing, from uniformly sorted, graded, and packed tomato fruit within three days. Evaluations on fruit incidence decay (rotting) are made visually by observing each tuber for any signs of dry and soft rots and incidence was recorded as a percentage of the total number of fruits in a sample. The number of rotten fruits within a sample was recorded for 3 weeks. It calculated the number of decayed and dividing by initial number of all fruit times 100.

$$\% \text{ Incidence} = \frac{\text{No.of infected fruit x100}}{\text{total no of fruit assessed}}$$

ii). *Disease severity rate:* Is requirement the 'area of a sampling unit affected by the disease, expressed as a percentage or proportion of the total area. In this case, the whole fruit was considered as 100% of severity, so an assessment of disease severity was done based on the area covered by the spot by using standard disease severity index

Sum of all disease rating x 100 Total no. of rating x maximum disease grade

iii).*Firmness:* The firmness of the fruit was measured by using a texture analyzer within intervals of 3 days from randomly selected fruits

iv).*Decay percentage (%)*

$$\text{Decay percentage (\%)} = \frac{\text{№ofdecayedX100}}{\text{total№of fruit}}$$

v). *Weight loss (%):* - It is calculated for each sampling interval date and converted into a percentage by dividing the weight change recorded on each sampling date by taking the initial weight as a reference.

$$\text{TWL (\%)} = [(initial\ weight - final\ weight)/initial\ weight)]\ x100$$

2.4.2. Chemical Quality Measurements

i). *PH:* The pH of blended and filtered samples was determined using a pH meter calibrated to the standard pH 4.0 and 7.0 buffer solutions [17].

ii). *Total soluble solid (TSS °brix):* Tomato fruit juice was extracted using a juice extractor and total soluble by refractometer. From the prepared tomato juice single drop was added to the adjusted refractometer and a record was taken.

iii).*The titratable acidity (TTA):* TAA was measured following the method developed. As a color-changing indicator, three drops of Phenolphthalein were added into 5 ml of tomato juice solution and steered slowly until the color changed to pink. The acid content of the tomato fruit sample was calculated based on the volume of 0.1 N NaOH used for neutralizing the acid content in the sample and multiplying by a correction factor of 0.0064 to estimate titratable acidity as a percentage of citric acid. The titratable acidity will be calculated using the following equation:

%TA = [mls NaOH used] x [0.1 N NaOH] x [milliequivalent factor] x [100] ml of sample

2.5. Data Analysis

The data were computed and analyzed statically by using SAS software with a confidence interval of 95% ($p<0.05$) and Mean values will be separated by LSD pairwise comparisons test**.**

3. Results

The total storage life of tomatoes under laboratory conditions was determined for 24 days. The packaging material for the PH value of tomato was highly significant ($P< 0.005$) all properties were shown in the following table.

Table 1. *Effect of packing materials physio-chemical properties on shelf life of tomato.*

Treatment	Physio-chemical properties						
name	WL%±SD	DI%±SD	DS%±SD	FIRMESS%±SD	PH%±SD	TSS%±SD	TAA%±SD
NO packing	22.33±1.3166	100±2.5298	20.33±1.7127	130±60.590	5±0.0558	5±0.8165	2.4667±0.5534
Nets	13.667±1.36	68.33±2.5298	9±1.7127	310±60.590	6±0.0558	7±0.8165	3.7±0.5534
DPB	11±1.3166	42.67±2.5298	4.667±1.7127	673.33±60.590	5.3667±0.0558	11±0.8165	2.6±0.5534
LTPB	9±1.3166	10±2.5298	3.66±1.7127	736.67±60.590	5.7±0.0558	9±0.8165	5.333±0.5534
CARTON	9.667±1.3166	6.67±2.5298	3±1.7127	743.33±60.590	5.2±0.0558	9±0.8165	4.5±0.5534
LSD at 5%	2.94	10.054	4.58	1659.45	0.005	1.05	0.48
CV	2.9335	5.6368	3.8161	13.500	0.1243	1.8193	1.2330

Key words: - WL (weight loss), DI (disease incidence), DS (disease severity), PH (power of hydrogen), TSS (Total Soluble Salts), TAA (Triable Acidity), DPB (Dark Plastic Bag), LTPB (Light Transparent Polyethylene Bag), LSD (Least Significance Difference), CV (coefficient of variance) and ± shows the significance of standard error for comparison.

3.1. PH Value

The highest PH value recorded for tomatoes packed in the different packing materials is, nets (6 ±0.0558) were greater than LSD values at 5%,1%, even at 0.1%, and control/ no packing with (5±0.0558). Among these results, the PH value closely varies when using different packing materials respectively within the other packing materials. So T2 (Nets) is superior and there are also significantly different from other packing materials. All 5 means are significantly different from one another. The concentration of acid decrease when temperature increase and then increases when the fruit is stored at 20°C [18].

3.2. Weight Loss

The weight losses are not much significant within the different packing materials. The packing materials were respiration and transpiration rate which are known to be the major cause of weight loss [19]. Similarly with this, on the 24th day of the storage period, tomatoes treated with chlorine showed minimum weight loss (4.9%) followed by (7.49%) when those were none treated. The high significance recorded during the 24 days of storage under laboratory conditions was no packing/ control (22.333%±1.3166) and the low recorded LTPB (9±1.3166). This result shows that lower temperatures can prevent weight loss.

3.3. Disease Incidence

The disease Incidence recorded high superior when the fruit was stored without packing, which is (100%±2.5298). Expect that the control treatment and the others homologically reduced respectively. The carton (6.667%±2.5298) was among others it is low recorded during 24 days intervals. Transpiration and subsequent water loss and cause of disease severity and Incidence can result from rapid loss of fruit quality due to metabolic changes which in turn reduce the volume of fruit, especially on the non-packing/ control treatment [20].

3.4. Disease severity

Relatively the disease severity shows similar to disease incidence significant variation shows.

3.5. Firmness

The Firmness percent interaction of packing materials with the tomato fruit stored under lab conditions during the 24 days storage, treatment five shows high superior which recorded carton (743.33N ±60.590) when compared with control (130N ±60.590). The firmness values were decreased in all the samples stored in different conditions and different packing materials [21] and [22].

3.6. Total Soluble Solids (°Brix)

The TSS content of tomato fruit was increasing 5% to 11% high significance with packing materials called DPB (11±0.8165) when compared with controlled (5±0.8165).

Changes in TSS contents were a natural phenomenon that occurred during ripening due to the conservation of starch into sugar [23]. The sugar content increase depending on the stage of ripeness at harvest and storage interval [24]. The TSS content was varied and related to close packing materials. The nets (7±0.8165), carton (9±0.8165), and LTPD (9±0.8165). This shows in each of the days of the interval the TSS content increased when using the closed packing materials. The interaction of treatments with the storage time shows that total soluble solids increase with the increase in ripening during the storage period.

3.7. Titrable Acidity (TAA)

The TAA lower recorded control/no packing (2.47±0.5534) and the high was LTPD (5.33±0.5534). Roncal-jimenez [25] showed the amount of organic acid usually decreases during maturity because they are a substrate of respiration. Generally, acidity decreases due to storage time. When coming to the packing materials' effect the titratable acidity no much significant within the treatment, but LTPB is high when compared to the other rest of one carton, Nets, DPB, and control respectively. Titrable acidity and ascorbic acid non-content significance of tomato fruits even up to the end of the storage period [26].

4. Conclusion

The total storage life of tomatoes under laboratory conditions was determined for 24 days. The packing materials were for the weight loss, Disease incidence, disease severity, firmness, pH, TSS, and TAA of tomatoes. The different packing materials under laboratory conditions were evaluated for quality. The final results generally coincided with my expected results. Based on the research results the following conclusions were drawn. The pH value was evaluated high superior to the treatments packed in LTPB (5.7%±0.0558) and its preferable materials to keep the acidity of the fruit. When storage time increases, it varies to increase within packing materials. Weight loss related to low temperature can prevent it. Except for the without packing all treatment were accepted weight loss and the T2 nets (13.667%±1.36) was the good materials among others. Total soluble salts were the packing material in the T3 DPB (11±0.8165) the most affect the TSS 0brix. The content of soluble solids progressively increased with storage time increased and to keep the titrate acidity decreased at storage time increased. Generally, acidity decreases due to storage time. The increment of soluble solid acid is caused by the biosynthesis processes or degradation of polysaccharides during maturity. The amount of organic acid usually decreases during maturity, because it is the substrate of respiration. Disease incidence and severity were very high in control as compared to others treatments. The firmness is also acceptable and excludes carton (743.33N ±60.590) treatment.

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