Evaluation of pot technology preservation techniques for tomato fruit in East Arsi, Ethiopia

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ABSTRACT

The aim of this study was to extend the shelf life of tomato fruits using pot in pot technology. Exposure of tomato fruits to high temperatures during postharvest reduces their storage shelf life. Pot in pot technology differs from common air conditioning and refrigeration technologies in that it can provide effective cooling without the need for external energy source. Pot in pot technology has been found to be an efficient and economical means of reducing temperatures and increasing humidity in an enclosure where the humidity is comparatively low. Consequently, Pot in pot is a low cost technology for storage of fruits. Pot in pot reduced the inside storage temperature 18.19 ^{o}C, the fridge to 11.57^{o}C while the average room temperature was 20.4 ^{o}C. The average inside storage relative humidity for pot in pot was 67.31%, fridge was 59.11% .while the average room relative humidity was 59.42 %. Highest pH value was recorded for tomatoes stored inside room temperature (4.71) followed by pot in pot (4.66), and least value was recorded for fridge storage method (4.43) on 12 days all at light red ripening stage. The total soluble solid(TSS) content of tomato stored at room temperature (1.02 ^{o}Brix) and inside fridge (1.01^{o}Brix) was the same as tomatoes stored inside pot in pot (1.01^{o}Brix) on 12 days of storage at light red ripening stage and the least TSS content was recorded inside fridge (1.01^{o}Brix) after 19 days of storage. The total titrable acidity was highest on tomatoes stored inside pot in pot (0.12%) and fridge (0.15%) while minimum TTA was recorded for room temperature (0.14%) after 12 days all at ripening stage.

Key words: tomato fruit, pot experiment, proximate composition analysis**,** Sensory Analysis.

Introduction

Evaporative cooling is the process by which the temperature of a substance is reduced due to the cooling effect from the evaporation of water. Besides this, evaporative cooling results in reduction of temperature and increase in relative humidity (Olosunde, 2006). Thus, Effective cooling can be accomplished by simply wetting a surface and allowing the water to evaporative. Losses after harvest are a major source of food loss. Farmers growing horticultural crops are facing high economic loss, because there have no means of increasing the shelf life of fruit and vegetables. On the other hand, the Post- harvest losses of perishable foods like fruits and vegetables are about 30%. According to Girma (2017) reported that the loss of vegetables between production and consumption is estimated to be 25-35%.High moisture content, insect infestation and damage during handling (packaging, storage and transportation) are the main causes of crop losses (EARO, 2000).

In order to extend the shelf life of fruit and vegetables, they need to be properly stored .Proper storage means controlling both the temperature and relative humidity of the storage area. The essence of storage is of great importance because not all the harvested vegetables or crops in general will be used immediately after harvest. So measures of preserving the vegetables before it exceeds its shelf life are of great importance (J.T.Liberty et al., 2013).

Exposure of fruits and vegetables to high temperatures during postharvest reduces their storage or shelf life. This is because as living material, their metabolic rate is normally higher with higher temperatures. Pot in pot technology differs from common air conditioning and refrigeration technologies in that it can provide effective cooling without the need for external energy source (for instance, electricity). However, lots of the farmers are not able to afford the cost of purchasing high technology storage equipment for their harvested fruits. Apart from this, Pot in pot technology has been found to be an efficient and economical means of reducing temperatures and increasing humidity in an enclosure where the humidity is comparatively low. Consequently, Pot in pot is a low cost technology for storage of fruits. Therefore, this study designed to evaluate the pot in pot and the refrigeration on the shelf life of tomato fruit.

Material and Methods

The Experiment was conducted in Kulumsa agricultural chemistry and nutritional research laboratories and debrezeit research laboratory. A total of 46 matured tomatoes fruits were collected from Horticulture farm of Kulumsa Agricultural Research Center. Randomly selected tomatoes fruit were divided into three treatments such as Pot in pot, Fridge and Room Temperature (Control). Each treatment contained 23 tomatoes fruit were considered into uniformity in maturity, shape and size. All the tomatoes were free of physical damage and infection.

Sample preparation

Samples of tomatoes were washed by scrubbing gently the fruit in warm water at a temperature of $43^{o}c$ containing hypochlorous acid 150ppm then the juice of tomatoes fruits were made and strained through muslin cloth to remove seeds and other extraneous material. Since the nature of the tomatoes fruit juice was semi-thick product, it would be mixed thoroughly. In order to determine the total solid content, the first pressed part of sample would be rejected and the reserved part would be selected for analysis.

Proximate composition analysis

The sample was subjected to proximate composition analysis such as Degree of deterioration (weight loss percentage), pH, Titrable acidity (TA) and Total Solid Soluble Content (TSS) according to AOAC (2006).

Temperature drop and Relative Humidity

Temperature and Relative humidity were measured during the storage period by using thermo hygrometer (Vici, 288 B-CTH, China). The inside storages were recorded two times per day (in the morning and afternoon).The parameters were monitored temperature and relative humidity were measured daily (Lertsatittanakorn *et al*., 2006).

Determination of Total soluble solid

Total soluble solids were determined using digital refractometer at room temperature. Initially the refractometer was calibrated with distilled water. Then small quantity of tomatoes fruit portion 2-3 drops of the homogensed sample were placed on the prism of the refractometer and the reading taken. Percent of total soluble solid were determined by using standard procedures according to AOAC (2006).

Determination of the deterioration degree (percentage Weight Loss)

The moisture content of the tomatoes fruit samples were indirectly measured by measuring the weight loss. The weight of each samples were measured before treatment and after treatment. The weight of the pot in pot preserved tomatoes fruit and also weight of fridge preserved were measured within six days interval.

Determination of pH

The pH of the tomatoes fruit samples were measured using a digital pH meter after calibrating of using standard buffer solution of pH 4 and 7.

Determination of Titrable Acid

From the mass of sample prepared for each tomato fruits 6g would be taken for analysis into a 100ml beaker. The sample taken would be diluted in 50ml of neutralized distilled water. From diluted sample 50ml of sample would be titrated by 0.1Nof NaOH by using 0.3 ml phenolphthalein as indicator during titration. Titrate each sample with 0.1 N NaOH to an end point of 8.2 (measured with the pH meter or phenolphthalein indicator) and recorded the milliliters (mls) of NaOH used. The report of acidity would be reported as ml of NaOH per 6g of the sample. Titrable acidity would be determined by titration method according to standard procedures of (D.Garner et al., 2005).

Sensory Analysis

The sensory attributes of General Appearance, Color, Firmness and overall acceptability were evaluated by using five hedonic scale (i.e 5=like very much, 4= like moderately, 3= neither like nor dislike, 2= unlike moderately and 1= unlike very much) by ten semi-trained panelists at every six days interval (Bai, *et al.,* 2003).

Result and Discussion

The evaporative cooler storages decreased inside storage temperature and increased the relative humidity as compared to control throughout the storage period. Pot in pot reduced the inside storage temperature 18.19 ^{o}C, the fridge to 11.57^{o}C while the average room temperature was 20.4 ^{o}C. The average inside storage relative humidity for pot in pot was 67.31%, fridge was 59.11% .while the average room relative humidity was 59.42 %. Table: 2 clearly revealed that there was difference in maintaining the storage temperature, while average best result was recorded for pot in pot storages.

Table:1. Average daily relative humidity of pot in pot, fridge and room (control) for 30 days.

	R. Temperature, Humidity (%)		**Pot in pot,** Humidity (%)			**Fridge,** Humidity (%)
Sample	Feb.	Feb.	Feb.	March	Feb.	March
A	59.50	59.50	68.50	62.20	64.25	54.20
B	52.83	52.83	63.17	60.17	60.83	54.83
C	61.33	61.33	70.00	73.50	62.67	60.50
D	64.00	64.00	72.30	68.60	63.50	52.10
E	59.42	59.42	68.49	66.12	62.81	55.41

Mean	59.416	59.416	68.492	66.118	62.812	55.408

Table: 2. Average daily temperature of pot in pot, fridge and room temperature (control) for 30 days.

	R. Temperature, Temperature(°C)		**Pot in pot,** Temperature(°C)		**Fridge,** Temperature(°C)	
Sample	Feb.	March	Feb.	March	Feb.	March
A	18.35	22.15	18.13	20.58	10.90	15.49
B	17.44	22.10	17.03	17.08	10.50	12.12
C	18.12	21.15	18.03	18.42	10.47	11.67
D	18.39	23.12	17.18	19.48	10.27	11.10
E	18.07	22.13	17.37	18.89	10.53	12.60
Mean	18.07	22.13	17.55	18.89	10.53	12.60

Highest pH value was recorded for tomatoes stored inside room temperature (4.71) followed by pot in pot (4.66), and least value was recorded for fridge storage method (4.43) on 12 days all at light red ripening stage. PH of the tomatoes increased with advancement of fruit ripening. Since acidity of the fruits was due to various organic acids that are consumed during respiration (Albertini et al., 2006) , the acidity thus decreased with advancing maturity or increasing storage duration with a corresponding increase in fruit pH (Moneruzzaman et al., 2009).Nirupama et al., (2010) reported that pH of the fruit pulp treated with postharvest treatments was found relatively in lesser range of pH (i.e. 4.20 to 4.26) as compared to the fruits of control set having highest pH (4.66) after 12 days of their storage. Okoli and Sanni (2012) also reported that pH value of tomato increased after 14 days of storage time.

The result on day 12, effect due to storage methods and ripening stages shows a highly significance difference at $p<0.05$. The total titrable acidity was highest on tomatoes stored inside pot in pot (0.12%) and fridge (0.15%) while minimum TTA was recorded for room temperature (0.14%) after 12 days all at ripening stage. In general tomatoes harvested at light red ripening stage showed higher total titratable acidity percentage as compared to ambient temperature storage. Titratable acidity of fruits was an important factor in determination of fruit maturity. Titratable acidity was given the total or potential acidity, rather than indicating the number of free protons in any particular sample. It is a measure of all aggregate acids and sum of all volatile and fixed acids (Naik et al. 1993). In general TA decreased with advancement in maturity and during the storage period. However it was rapid on tomatoes stored at room temperature as compared to those stored inside pot in pot as well as fridge.

The total soluble solid content of tomato stored at room temperature (1.02 ^{o}Brix) and inside fridge (1.01^{o}Brix) was the same as tomatoes stored inside pot in pot (1.01^{o}Brix) on 12 days of storage at light red ripening stage. The TSS value for those stored inside room temperature (1.015^{o}Brix), similar with pot in pot (1.015^{o}Brix) but the least TSS content was recorded inside fridge (1.01^{o}Brix) after 19 days of storage. The total soluble solids acts as a rough index of the amount of sugars present in fruits. It is the amount of sugar and soluble minerals present in fruits and vegetables. Generally TSS increased with advancement in maturity and during storage period. The soluble sugars glucose and fructose is the largest contributor to the total soluble solids. During ripening the degradation of cell wall polysaccharides occurred which led to the release of oligosaccharides (Dumville and Fry, 2000). Azzolini (2002) also confirm TSS content depends on the maturity stage, and it generally increased progressively during the ripening process due to the hydrolysis of polysaccharides to maintain the respiration rate. Overall soluble solids showed a good correlation with the sum of glucose plus fructose concentration. Islam et al, (2012) reported that the TSS of tomatoes increased from 4.20 to 5.00 after 7 days of storage at room temperature and from 4.10 to 4.99% at ZECC after 17 days of storage.

The result of sensory evaluation performed on pot in pot storage with tomatoes was significant difference ($P<0.05$). The general appearance was the maximum scored obtained treated with pot in pot than the fridge and room temperature. The firmness was the highest scored stored at the pot in pot, followed by fridge and less firmness was scored for tomatoes stored at room temperature. The firmness was directly related with the fruit deteriorating. It is often inversely related ripening, implying that, as ripening progressed, pulp firmness declined (Hiber and Hardy, 1994). The firmness was also correlated with the color. The fruit color was gradually changed depending on the storage condition. The tomatoes which stored at pot in pot were obtained highest acceptability than the other. The least acceptability was observed tomatoes stored at room temperature.

Conclusion

The experiment revealed that proper storage method used for extended the shelf life of perishable. Among the storage method the pot in pot maintained the fruit quality and extended the shelf life of tomato as compared to storage at room temperature. The maximum number of days for tomatoes stored inside pot in pot, fridge and room temperature were 30 days, 24 days and 12 days respectively. Generally the evaporative cooling decreased the storage temperature and increased relative humidity as compared to room temperature.

Table: 3. The physicochemical analysis of mean result of tomato fruits stored inside pot in pot, fridge and room temperature.

Treatment	TA	pH	TSS
Pot in pot	0.12^{b}	4.60^{a}	3.36^{b}
Refrigerator	0.15^{a}	4.44^{b}	3.84^{a}
Room Temp.	0.14^{b}	4.61^{a}	3.27^{b}

Where**:** TA= Titratable acidity, TSS= Total soluble solid.

Table: 4. The mean weight loss percentage of tomato fruits stored inside pot in pot, fridge and room temperature.

Experiment	Pot in pot	Refrigerator	Room temperature
%Mean wt. loss	21.59	10.28	60.83

Table 5: Mean of Sensory evaluation performed on different samples of tomato fruit.

Sensory Evaluation of Panelist Perception				
Treatment	Appearance	Firmness	Color	Overall
Pot in pot	3.84 ± 1.04^{a}	4.07 ± 0.87^{a}	4.08 ± 1.03^{a}	4.00 ± 0.92^{a}
Fridge	3.92 ± 0.94^{a}	3.59 ± 0.96^{b}	3.87 ± 0.90^{a}	3.80 ± 0.87^{a}
Room temperature	3.09 ± 1.55^{b}	3.67 ± 1.34^{b}	3.31 ± 1.41^{b}	3.36 ± 1.37^{b}

Values are means of 21 untrained judges.

Means with different superscripts within the same column are significantly from each other ($P<0.05$).

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