

**ASSESSMENT OF TOMATO FRUIT SHELF-LIFE STORED ON TOMATO (*Solanum Lycopersicum*)
PLANT USING PERICARP PERMEATION INDEX**

Chris I. Igbozuruike.

Imo State University Owerri.

Email: farstdc@yahoo.com

Abstract

Cherry tomatoes established at the greenhouse at Anambra/Imo River Basin Authority Development Authority's Agricultural field situated at Agbala town in Owerri North LGA, Imo state Nigeria were studied using Electrolyte leakage as a pericarp permeability index to examine shelf life of tomatoes fruits store on tomato plant. Water was delivered through installed water hose with nozzles of 0.3mm orifice for efficient watering, and was delivered at 0.2liters a day per plant but was increased to 0.5l and 1L per plant per day at different months, delivered morning and evening. Fertilizer (NPK 15:13.10) at the rate 120kg/ha was added at transplanting, and NPK 10:15:15 at the rate of 90Kg/ha was added 8 weeks after planting. Pest control and weeding were done manually. The following parameters were taken at maturity(harvest) stage: weight of tomatoes at orange colour ripe stage, texture of the fruits, electrolyte Leakage (EL), proximate composition which included- percentage moisture, lycopene level, protein, lipid levels, ash content, energy content, crude fibre and total sugar were taken respectively. The sampling and analysis were repeated every 4 days after first harvest till 90 days after orange colour ripe. The pericarp permeability was measured using Electrolyte leakage. The result showed that the tomato fruits while still hanging for more than 80days after maturity, declined drastically in all the parameters studied at 76day after orange ripe. As the electrolyte leakage increased, with the corresponding decrease in moisture content, undesirable features like squishy texture emerged. Total sugar decreased; ash, energy, crude fibre and protein all declined at moisture level of 31-5 and electrolyte leakage of 10.1 this indicated that though tomatoes can be stored on plant where and when necessary to preserve quality, but it is advised not to be allowed hanging on the plant after 76 days of orange colour ripe because as the tomato plant begins to senesce, the plant tend to reabsorb nutrients already incorporated into the plant and fruit tissue. Saltveit (2002). and other studies correlations between electrolyte leakage and moist content showed that at a higher electrolyte leakage of between 8-12, with moisture level of 40-25%, tomato fruits quality begins to decline drastically. Therefore tomatoes fruits should not be left hanging on plant after 76 days after emergence of orange colour for healthy tomato fruits.

Keywords: Post-harvest, Shelf-life, Tomato, yield parameters

INTRODUCTION

Postharvest handling and storage of produce often creates serious challenges depending on locations and the yield involved. To native farmers, they depend on quick market sales to avoid fruit rot and undesirable textures development especially when perishable goods are involved. With middle class farmers, yields can be processed into other products just to protect lost, and when damage to produce is eminent, some farmers use cold rooms where available, for a fee, to preserve products. While some produce can stay longer hanging on the parent plant after peak of maturity and ripening before decay or reduction in yield quality occurs, many other produce do not (Couey, 1982). For non-climacteric fruits like oranges, pineapples, grapes and cherries, ripening does not continue once removed from the plant and therefore attains full maturity on the plant before harvesting. For Climacteric crops like bananas, pears, melon and even avocados, ripening continues due to the presence of ageing hormone called ethylene. The overall quality of the produce after reaching their prime will start dropping, and with some plants more rapidly than over ripening, softness, decay and rot occurs (Cook, et al., 1958). To some crops, undesirable texture occurs, like in the case of pear that becomes gritty. Tomatoes is a climacteric fruit meaning that the fruit continues to ripen significantly after harvest which is characterized by respiration surge and ethylene hormone production. Shelf life therefore describes the length of time for which an item remains usable, fit for consumption, or saleable. King *et al.* (1983) described shelf life as the recommended maximum time for which products or fresh (harvested) produce can be stored,

during which the defined quality of a specified proportion of the goods remains acceptable under expected (or specified) conditions of distribution, storage and display. Pericarp permeation is one method used to evaluate fruit shelf life using Electrolyte leakage method. The conductivity test assesses membrane permeability via the measurement of ion leakage from the plant tissue into a surrounding solution (Saltveit, 2000). Ion leakage measurements the extent of cell wall damage which consequently affect the tomato quality. Farmers often store produce on plants without knowing shelf life baseline. The study examined the shelf life of tomato fruit stored (hanging time) on tomato plant using Electrolyte leakage technique of pericarp permeation.

MATERIALS AND METHOD

Study Area

The study was carried out at Anambra-Imo River Basin Development Authority Agbala. The controlled (Greenhouse) agro-field in Agbala in Owerri North LGA area of Owerri Imo State Nigeria was used. Owerri lies at latitude 5.5096° N, and 7.0391°E.

Field Operations:

The tomatoes was planted in the greenhouse of Anambra Imo River Basin Development Authority Agrofield, in Agbala Town in Owerri North LGA in Imo State Nigeria. The tomatoes established in the greenhouse with ridges of 0.5m wide and 5m length made. Water was delivered through installed water hose with nozzles of 0.3mm orifice for efficient watering, and was delivered at 0.2liters a day per plant but was increased to 0.5l and 1L per plant per day at different months, delivered morning and evening. Fertilizer (NPK 15:13:10) at the rate 120kg/ha was added at transplanting, and NPK 10:15:15 at the rate of 90Kg/ha was added 8 weeks after planting. Pest control and weeding were done manually.

Table 1. Average monthly weather data during the months in 2016

Months	Day Water SS (liter per plt)	Sunshine Hours	R/Humidity (%)	Temp. (AV.)	Pressure (KPa)
Mar.	0.2	6	69.8	34	101.52
April	0.5	5.5	72.6	34	101.38
May	0.5	5.5	78	33	101.52
June	1	5	89	33	101.22
July	1	4	90	32	101.61
Aug	0.5	5	89	33	101.46
Sept.	0.2	6	88	34	101.73

Figure 1. Ripe Tomatoes on the plant showing water hose for drip irrigation.



Sampling.

Matured tomatoes were sampled at orange color as showed in figure 1. This was maturity stage at which 80 percent of the tomatoes were ripe. Sampling was done every 4days after orange colour until 3 months. The Following parameters were taken: moisture content. This was done using five (5) tomato fruits randomly selected. For fruit weight; twenty (20) randomly selected fruits were weighed every four (4) days after the first sampling. Fruit dropping; this was done by picking and counting the number of tomato fruits on the ground on each sampling day. Nutrient composition; proximate analysis was does in the laboratory. For plant transpiration; water lost from the tomato plant was done using lysimeter. Pericarp (permeation) permeability was done using electrolyte leakage method as described by Saltveit (2002). 0.25mol/L of sucrose solution is used after pericarp tissue of 1cm in diameter and 0.4cm thickness were placed in an excited disk. Due to concentration gradients between the tissue and surrounding solution, ions flowed out from the plant cells and into the solution. The resulting change in electrolytic conductance of the solution was monitored with a conductivity meter. The measurements were taken and data analyzed.

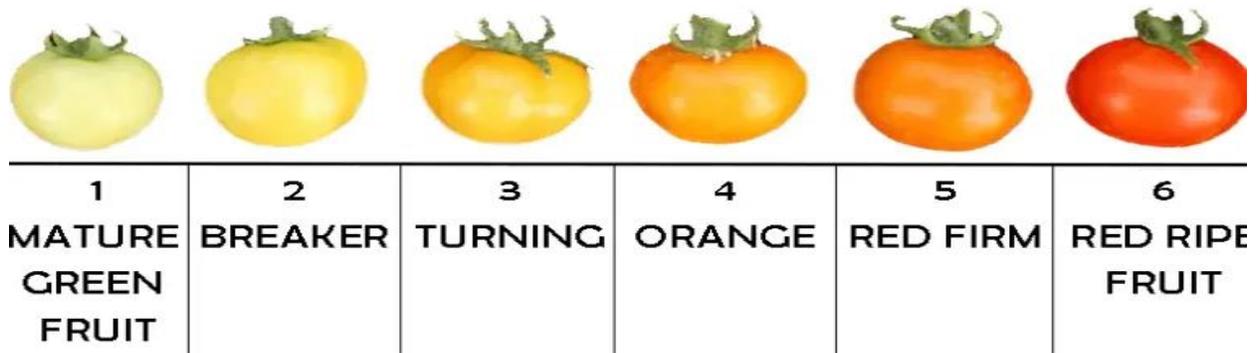


Figure 2: Tomato Color Chart

Data Analysis

Electrolyte leakage (EL) were measures in the laboratory as discussed by Saltveit (2002).and values of data produced, and means obtained and presented in tables and chart.



Figure 3: Tomato fruits on the plant 8 weeks after first harvest



Figure 4: Tomato fruits on the plant 10 weeks after first harvest

RESULTS AND DISCUSSION

- As showed in table 2. Harvesting was done every 4 days after the first harvest at orange color. Some literature suggest harvesting at breaker. However, for analysis that involved electrolyte leakage, harvesting tomatoes when the ripening is nearing completion is crucial as described by King *et al.* (1983). The weight of tomato fruits at different stages of harvest were significant different when compared to the harvest at orange color, that is Day O. As supported by Autio *et al.* (1986), tomato fruits continue to develop and gain more weight as hang time continues during the ripening peak. The Electrolyte leakage (EL) was insignificantly different until about day 76 when EL values rapidly increased significantly. The tomato fruits continue to hang on the tomato plant extending hang time without dropping on the ground. This was insignificantly different between harvest days. The tomato plant continues to slowdown water loss as senescence approaches, and these were significantly different between harvest days. The proximate compositions were also significantly affected. The moisture content of the fruits were significantly different as the fruits continued to increase and maintain moisture content while hanging on the plant. Lycopene varied significantly and the lowest occurring 90days after first harvest. The energy levels of the fruits were also significantly different and the energy content dropped significantly as the fruits continues to hang on plant. Lipid, ash, crude fiber and total sugar where

were all affected significantly. The parameters increased significantly until day 76 of the harvest when the values rapidly declined.

Table 2: Means of parameters as influenced by days of harvest.

hvt	Wgt (g)	EL	Dp	trs	Proximate Analysis							Tst	
					mtr g/Kg	lyco mg/100g	Ener Kca/100g	prt	lpd g/kg	ash g/kg	C fib g/kg		T sgr g/100g
D0	104.2	2.1	4	2.4	92.6	10.3	37.4	18.4	4.6	12.6	12.3	51.7	Fm
D4	118.1	2.1	5	2.7	93.2	11.6	44.2	26.7	5.0	14.0	13.8	54.8	Fm
D8	129.4	2.2	5	1.8	94.1	13.2	45.8	26.5	5.0	14.2	13.8	58.3	Fm
D12	129.4	2.2	4	1.6	95.3	13.1	50.1	26.2	6.1	14.5	14.5	58.7	Fm
D16	123.8	2.2	4	1.5	95.1	12.7	50.2	26.2	7.3	16.9	15.2	58.9	Fm
D20	126.1	2.2	3	1.8	95.6	12.5	50.1	26.2	7.2	16.9	15.8	60.2	Fm
D24	129.4	2.2	3	1.7	95.7	12.1	50.3	26.2	7.3	16.8	15.9	64.7	Fm
D28	125.1	3.1	3	1.6	92.1	11.6	46.9	26.2	7.4	18.3	14.4	63.2	Fm
D32	124.2	3.1	2	1.6	85.5	11.2	46.8	26.2	7.5	18.1	14.2	63.1	Fm
D36	123.2	3.1	2	1.6	85.9	10.8	46.7	26.1	8.3	18.1	14.2	63.1	Vfm
D40	129.8	3.1	2	1.6	85.1	10.7	38.2	24.2	7.6	18.1	14.1	63.1	Vfm
D44	128.9	3.1	1	1.5	72.6	10.5	37.6	24.2	7.2	18.1	14.5	63.1	Vfm
D48	129.6	3.2	1	1.5	72.4	10.3	37.3	24.2	6.3	18.1	15.1	63.1	Vfm
D52	127.2	3.5	1	1.5	72.1	10.1	34.7	24.2	6.3	18.1	15.1	63.1	Vfm
D56	110.5	4.6	0	1.5	67.2	8.4	31.9	24.2	6.3	18.1	14.3	65.7	Ss
D60	90.5	4.8	0	1.5	52.1	8.2	30.1	23.9	6.3	18.1	13.6	43.1	Ss
D64	86.3	4.7	0	1.5	50.4	7.5	30.1	20.7	6.1	13.2	13.3	40.2	Ss
D68	63.7	5.4	0	1.3	50.2	3.3	30.1	19.5	5.2	12.6	12.7	36.6	Ss
D72	62.1	6.1	0	1.3	56.1	3.0	28.5	17.3	5.2	12.2	11.6	25.5	Ss
D76	50.6	10.1	0	1.2	31.5	3.0	20.8	14.1	4.2	9.5	11.5	22.9	Tg
D80	47.1	11.1	0	1.1	30.4	3.0	20.4	14.4	4.1	8.4	11.3	22.5	Tg
D84	43.8	17.2	0	0.8	27.8	1.1	20.3	10.2	3.3	8.4	11.4	20.7	Tg
D88	41.3	19.4	0	0.4	26.1	1.1	20.1	8.4	3.2	8.4	10.1	20.1	Tg
D92	40.2	19.6	1	0.2	20.9	0.6	20.1	7.1	3.1	8.1	8.5	17.3	Tg

Hvt-harvest, Wgt weight, EL Electrolytes leakage, Dp dropping, Trs transpiration, D0-D92 days after first harvest, mtr moisture, lyco lycopene, Ener energy, prt protein, lpd lipid, C fib crude fibre, T sgr total sugar. Fm firm, Vfm very firm, Ss squishy, Tg turgid.

The result indicated that the measured parameters increased after first harvest because the fruits were still hanging on the plant and chemical actions still taken place until a point where the plant starts senescing, and the parameters start decreasing except electrolyte leak which increases indicating cellular damage. Increase in Electrolyte leakage is an indication of cellwall damage and reduction in yield quality (Gonzalez *et al.*, 2001). Hills and Remigereau (1997) also demonstrated that water in three compartments of a plant cell (vacuole, cytoplasm, and cell wall) could be differentiated based on MR transverse relaxation time, T_2 , and electrolyte leakage. Values of the key parameter, moisture, reduced significantly at day 76, and this sharply drop reflected across other parameters. As reported by Marangoni *et al.* (1996), a sharp loss of moist is an indication of nutrient leak, which often results in the development of undesirable texture to cushion the effect of physiochemical changes. Saltveit (2002). and other studies correlations between electrolyte leakage and moist content of tomatoes showed that at a higher electrolyte leakage of between 8-12, with moisture level of 40-25%, tomato fruits quality begins to decline drastically.

CONCLUSION.

The result showed that tomato fruits can be stored on tomato plant (hanging time), however, not longer than 76 days after orange color ripening even if the fruits still hand on the plant and the texture firm. The fruit quality drastically reduced after this time range and much may have happened to the fruits before this baseline that studies may not reveal. This was to ensure that quality of produce is preserved. If farmers are to store tomato on plant, temperature of between 25^oc to 35^oc is critical to avoid sunscald. The Farmers with postharvest challenges can allow the fruits to hang on plant for 2 months after orange color provided the farmers timed their planting to accommodate harvesting during stated temperature ranges, and also have effective pest management techniques in case of occurrence.

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