Quality Deterioration of Tomatoes Using Three Different Storage Methods

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Doi:10.5901/mjss.2012.v3n16p46

Abstract

*Study was conducted at the Microbiology laboratory of Lagos State Polytechnic, Ikorodu to determine quality deterioration of tomatoes sample using plastic, carton and basket storage method for period of 7 and 14 days respectively. 1000g matured tomatoes sample were taken from a farm settlement at Odogunyan-Ikorodu, Lagos to determine the physiochemical properties; moisture content (MC), protein (P), fat (FT), fibre (FB), ash (A) and vitamin 'C' (VC) of the produce before and after storage, also, microbial count and pathogenic presence after 24 and 48 hours of storage. Result obtained showed 95.00%MC, 2.21%P, 0.30%FT, 0.81%FB, 2.34%A and 67.50mgVC before storage. Tomatoes stored in the carton had the highest nutritional values in terms of quality; 55.48%MC, 0.85%P, 0.18%FT, 0.58%FB, 1.00%A and 2.50mgVC after 14 days. Penicillium, green fungi which grows in ripening fruit was found in the plastic after 48 hours with about 2.89 * 10^6 colony count while, sample stored in the carton were more susceptible to less colony count (1.52 * 10^6) of fungi after 48 hours. The carton gave better results when compared to basket and plastic methods of storage in the study area as far as these quality attributes assessed are concerned.*

Keywords: *Quality, deterioration, plastic, carton, basket.*

Introduction

Vegetables are of great nutritional value, because they represent a source of vitamins and minerals, essential for human diet. Its production can be adopted as a strategy for improving livelihood and alleviating the nutritional status of the people. It is the answer to the perpetual problems of hunger and malnutrition in the country. In Nigeria, many children suffer from vitamin "A" deficiency, a nutritional problem that can be reduced by regularly eating of fruits and green leafy vegetables (Olaniyi, Akanbi, Adejumo & Akande, 2010). Vegetable production forms about 25% of the major food crops cultivated in the tropics as a means of livelihood for some section of the population (Kra & Bani, 1998). Vegetables in their fresh forms contain high percentage of water; they are living and hence carry their physiological function of respiration. They absorb and release gases and other materials from their environment. These activities lead to their deterioration in transit and storage which is more rapid in conditions of high temperature and humidity, which leads to heavy losses.

Tomatoes (*Lycopersicon esculentum*), a fleshy berry regarded as very popular perishable fruit as well as vegetable grown throughout the tropical and temperate regions of the world. (Okorie,

Nwanekezi & Okoro, 2004). Olaniyi *et al* (2010) reported that tomato is one of the most important vegetable crops grown all over Nigeria. It is the world's largest vegetable crop after potato and sweet potato. In Nigeria, tomato is regarded as the most important vegetable after onions and pepper. Mongabay (2011) revealed that tomatoes are planted by an estimated 85% of the gardens each year and yield as at 2009 is 59,790 Fc in Nigeria. (calculated data). If well managed, tomato is highly productive. Cropping of tomatoes during the wet and dry seasons contributes immensely to the national requirement but the bulk of production is from the dry season. Olaniyi *et al*, (2010) reported that the yield of tomato in Nigeria is low; the average in Western part of the country being only about 5 tones per hectare and in growing areas of Northern Nigeria is 20 tones per hectare. One of the reasons for this low yield in Nigeria is poor fruit set resulting from temperatures that are generally above optimum range for good fruit set. Adelana (1975) as cited by Olaniyi *et al*, (2010) attributed poor tomato yield to non-development of flowers into fruits. He found that only 50% of the flowers produced developed into fruits. Thus sink size was a limiting factor to fruit production in tomato. Ripe tomatoes contain about 94% water as well as vitamins A; B and C. whole red, ripe tomato contains nearly all the vitamin C activity in the reduced ascorbic form (Okorie, Nwanekezi & Okoro, 2004).

Tomato is currently a popular fruit vegetable in Nigeria, however, its production in Nigeria is low compared with those of the temperate zones due to differences in crop environmental conditions, lack of high yielding varieties and cultural practices applied to the crop on the field. It is possible to alter tomatoes' storage environment to suit the moisture, air and heat requirements and the extent to which changes take place in fruits during heat treatment depends upon the type and quality of the fruit and condition of processing (Okorie *et al*, 2004). The purpose of the study is to examine the rate of deterioration in terms of qualities of tomatoes during storage, while specific objectives are:

1. To determine the rate of deterioration of harvested tomatoes using different storage materials such as baskets, plastic, carton and ambient condition.
2. To determine the physiochemical attributes; moisture content, protein, fat, fibre, ash and vitamin 'C' before and after storage.
3. To determine the extent of mechanical and microbial damages in stored tomatoes.

Methods and Procedure

Wholesome tomatoes were picked from a farm settlement beside Lagos State Polytechnic, Ikorodu. These samples were taken to the laboratory to carry out both physiochemical properties and microbial analysis. Physiochemical attributes carried out were the determination of the moisture content, protein, fats, fibre, ash and vitamin C content while he microbial load using saboraud agar was also done. The weights of the sample from the farm were taken before storage using digital weighing balance. 1000g of tomatoes were stored in storage containers such as plastic bowl, basket and carton. These samples were eventually picked for laboratory analysis after 7^{th} and 14^{th} days. Samples were analyzed chemically according to official method of analysis described by the Association of Official Analytical Chemist (A.O.A.C, 1970,1984, 1990, 1998). All analyses were carried out in duplicates.

Determination of moisture content

Moisture content was determine by the following apparatus; oven (Gallen kamp, England), crucibles,

balance and desiccators. 2g of the samples were weighed into a previously weighed crucible. The crucible plus samples taken were then transferred into the oven set at 105^{o}C to dry to a constant weight for one hour. At the end of the one hour, the crucible plus samples were removed from the oven and transferred to desiccators, cooled for ten minutes and weighed. Thus:

The weight of empty crucible				W_0
Weight of crucible plus samples				W_1
Weight of crucible plus oven-dried sample				W_2
% Moisture	=	$\frac{W_1 - W_3}{W_1 - W_0}$	x	$\frac{100}{1}$

Determinations of vitamin C:

5ml of tomatoes sample was pipette into a 100ml volumetric flask, 1ml of acetic acid was added plus 1ml of chloroform before titrate to known volume and get a distinct end point. It was titrated with dye in the burette until a faint pink color was obtained and titrate value was recorded. The procedure was repeated, that is, titration with blank using 3ml of distilled water and 1ml of acetic acid, were titrated against dye. Titter value was recorded as blank.

Determination of protein in tomatoes

10ml of the samples were pipette into 500ml of conical flask, 0.5ml of phenol, 0.4ml of saturated potassium oxylate, 2ml of formaldehyde was added respectively. It was titrated with sodium hydroxide into the burette until a faint pink color was obtained.

Determination of fat in tomatoes

The following apparatus were used to determined fat in tomatoes samples; Sox-let apparatus and accessories, oven, desiccators and analytical balance. Petroleum spirit at (40 – 60^{o}C b.pt) was used as reagent. 1gm of tomatoes samples were weighed into fat free extraction thimble and plugged lightly with cotton wool. The thimble was placed in the extractor and fitted up with reflux condenser and a 250ml sox-let flask which has been previously dried in oven was cooled in the desiccators and weighed. The sox-let flask was then filled to ¾ of its volume with petroleum ether at boiling point between 40^{o} – 60^{o}, extractor plus condenser set was placed on the heater for six hours with constant running water from the tap for condensation of ether vapor. The set is constantly watched for ether leaks and the heat source is adjusted appropriately for the ether to boil gently. The ether is left to siphon over several times, at least 10 – 12 times until it is short of siphoning. It was after this, it was noticed that any ether content of the extractor is carefully drained into the ether stock bottle. The thimble containing samples were then removed and dried on a clock glass on the bench top. The extractor flask and condenser was replaced and distillation continues until the flask is practically dry. The flask which now contains the fat or oil is detached, it exterior cleaned and dried to a constant weight in the oven. Thus, if the initial weight of dry sox-let flask is W_o and the final weight of oven dried flask + fat is W_1, percentage fat is obtained by the formula:

$$\frac{W_1 - W_0}{\text{Weight of sample}} \times \frac{100}{1}$$

Determination of ash

Porcelain Crucible, desiccators, analytical balances and a Furnace were the apparatus used to determine ash content of tomatoes sample. 2.0gm of the sample were weighed into a porcelain crucible then transferred into the muffle furnace set at 550^{o}C and left for about 4 hours (sample turned to ash). The crucible and its content were air dried at 100^{o}C; room temperature in a desiccators and weighed. This experiment was replicated and percentage ash was calculated using the formula below:

$$\frac{\text{Weight of ash}}{\text{Original weight of sample}} \times \frac{100}{1}$$

Determination of fibre

Apparatus used were: Heating mantle, crucibles, furnace, sieve cloth, fibre flask, funnel, analytical weighing balance, desiccators and 0.255N H2SO4, 0.313N NaOH and Acetone as reagents. 2.0gm of the sample was accurately measured into fibre flask and 100ml of 0.255N H2SO4 added. The mixture was heated under reflux for 1 hour with the heating mantle. The hot mixture was filtered through a fibre sieve cloth. The filtrate obtained was thrown off and the residue was returned to the fibre flask to which 100ml of (0.313N NaOH) was added and heated under reflux for another 1 hour. The mixture was filtered through a fibre sieve cloth and 10ml of acetone added to dissolve any organic constituent. The residue was washed with about 50ml hot water on the sieve cloth before it was finally transferred into the crucible. The crucible and the residue were oven – dried at 105oC overnight to drive off moisture. The oven-dried crucible containing the residue was cooled in desiccators and later weighed to obtain the weight W1. The crucible with weight W1 was transferred to the muffle furnace for ash at 550oC for 4 hours. The crucible containing white or grey ash (free of carbonaceous material) was cooled in the desiccators and weigh to obtain W2. The difference W1 – W2 gives the weight of fibre.

The percentage fibre was obtained by the formula:

$$\frac{W1 - W2}{\text{Weight of sample}} \times \frac{100}{1}$$

Determination of mechanical injury

The tomato fruits were determined by visual observation whether they were susceptible to injury because of the shape, size and structure and their relatively soft texture, high moisture content and the need for relatively handling during storage.

Determination of microbial damage:

10g of tomatoes was weigh using digital weighing balance into mortar, the sample were crushed with distill water and mixed thoroughly to give a homogenous final concentration of 1gm. Microbial population count was carried out after 24 and 48 hours respectively using a sterile test tube.

Results

Data in Table 1 shows the initial level of physiochemical properties of tomatoes sample before

storage; moisture content (MC) =95%, protein=2.21%, fat=0.30%, fibre=0.81%, ash=2.34% and vitamin C=67.50mg. This level of physiochemical properties defer from physiochemical properties that were obtained from two varieties of tomatoes, Ogbomosho local and Ibadan local: 42.55% and 29.39% protein content, 3.72% and 3.86% fat content and 6.94% and 7.42% fibre as reported by (Olaniyi *et al* 2010). These deviation could be attributed to differences in ecological distribution of the tomato varieties and genetic differences among the varieties. However, the moisture content of 95% for this study is close to the work of Okorie *et al* (2004) that reported 93%MC and Idah & Aderibigbe (2005) 92.2%MC of harvested sample of tomatoes before storage.

Table 1: *Physiochemical properties of tomatoes before storage*

Properties	Scale
Moisture	95%
Protein	2.21%
Fat	0.30%
Fibre	0.81%
Ash	2.34%
Vitamin C	67.50mg

During the process of storage, it was observed that, the rate of deterioration in plastic storage method was higher than the other three method used, where the color of tomatoes changed from red to yellow. Skin texture was very soft and produced offensive odors. Deterioration in basket is next to plastic while sample stored in the carton were more susceptible than the other two storage method used. Table 2 shows variance in level of deterioration between 7 days and 14 days of storage in the three methods used. Materials stored in the carton absorbed water from the tomatoes which made the tomatoes to dry to some extent. But at 14 days of storage there were rapid rate of spoilage in all the storage method used and loss of qualities of nutritional value during the process of storage, though in the carton storage material, the rate of deterioration is not as high as other storage materials.

Table 2: *Physiochemical properties of tomatoes after 7th and 14th days of storage*

Storage containers	Protein		Moisture content		Ash		Fibre		Fat		Vitamin C	
Days	7	14	7	14	7	14	7	14	7	14	7	14
Basket	1.04	0.51	89.88	55.91	1.39	0.85	0.65	0.35	0.23	0.16	4.83	2.25
Carton	1.12	0.85	92.13	55.48	1.42	1.00	0.67	0.58	0.29	0.18	5.00	2.50
Plastic	0.96	0.35	89.56	50.65	1.33	0.55	0.55	0.32	0.18	0.13	4.50	2.10

It was observed that within 24 hours microbial count in plastic method of storage had the highest microbial load (2.00 x 10^{-6} cfu) while storage of tomatoes sample in carton and basket were 0.50 x 10^{-6} and 0.10 x 10^{-6} respectively. Also, the plastic storage method of tomatoes sample showed the highest microbial load of 2.89 x 10^{-6} cfu within 48 hours of microbial analysis than carton storage method (1.52 x 10^{-6}cfu) and basket storage method of tomatoes sample (2.51 x 10^{-6} cfu). This study therefore, shows a distinction from the study of Idah & Aderibigbe (2005) that reported a microbial count of 3.6*10^{3} after 24 hours for sealed high density polythene film and traditional open storage method. Also, the report of okorie *et al* (2004) also showed a discrepancy in microbial count of fungi (38 * 10^{2}). Table 3 and 4 shows the colony count, color change and pathogens present in the sample of tomatoes studied. A white color was significantly observed for

both carton and basket storage method after 24 hours and white color of tomatoes sample after 48 hours in carton storage method.

Table 3: *Microbial analysis and pathogenic of tomatoes after 24 hours (cfu)*

Storage containers	Colony count	Color change	Pathogenic (fungi)
Plastic	$2.00 * 10^6$	Brown	Alternaria spp.
Carton	$0.50 * 10^6$	White	Serratia spp.
Basket	$0.10 * 10^6$	White	Serratia spp.

Table 4: *Microbial analysis and pathogenic of tomatoes after 48 hours (cfu)*

Storage containers	Colony count	Color change	Pathogenic (fungi)
Plastic	$2.89 * 10^6$	Green	Penicillium
Carton	$1.52 * 10^6$	White	Serratia spp.
Basket	$2.51 * 10^6$	Brown	Alternaria spp.

The most predominant moulds isolated in this study were penicillium, alternaria spp. and serratia spp. The genus penicillium spp. isolated shows one of the three major myxotoxins producing fungi, bluish green fungi that grow in ripening fruit. The discoloration coupled with the off flavor of the tomatoes sample are due to the activities of the infecting mould species, moulds are generously endowed with extracellular proteolysis or lipolytic enzymes and so can cause softening of food products. Moulds growth also causes off flavor in foods. Changes in appearance of food have been related to mould growth spores of various species which are heavily suspended in air especially in an untidy and unhygienic environment. These copulating moulds therefore easily get in contact with foods that are openly displaced in basket. Most of the mechanical injuries are inherently susceptible because of their size, shape and structure, their relatively soft texture, high moisture content and the need for relatively frequent handling during harvesting. Various type of mechanical injury (surface injury and impact bruising) can occur at any point in the time of harvest to consumption.

Conclusion

Tomatoes in the carton had the most extended shelf-life due to the most conducive environment for storage as observed in the result of this study. It also had the highest nutritional values. Tomatoes in basket take the next in term of shelf-life to carton; this is due to the design and shape of the materials. The tomatoes in plastic had the lowest storage life due to the heat being generated from the environment, hence, leads to rapid rate of deterioration of tomatoes in the storage method and lowest nutritional value. Therefore, it is recommended from this study in order to improve the post harvest handling of tomatoes that carton containers should be design to help the handlers and storage of tomatoes for at least few days before it gets to processing or final users.

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