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Variation of Physicochemical Characteristics of Tomato Under Different Traditional Forms of Conservation

Rafael Francisco Nanelo[a*] and António Elísio José[a]

[a] Food Processing Engineering, Agriculture Department, Higher Polytechnic Institute of Gaza (ISPG)
[*]Corresponding author
rafael.nanelo@ispg.ac.mz
Tel: +258866665242

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Abstract

Tomato is a fruit rich in vitamins and minerals, contains vitamin C and flavonoids, which prevent heart disease, strokes, chickenpox and cancer. In the world, tomato is considered as one of the main popular fresh products. Inappropriate storage can cause high losses in quantity and quality. Storage mechanisms, as well as, conservation methods can play a significant role to reduce postharvest losses by maintaining products and ingredients in an environment that protects their integrity. Drying, curing and freezing are some methods of conservation. The study evaluated the physicochemical quality of tomato, variety CAL J, exposed to different conservation techniques and environment. This study used a 2x3 factorial design with 6 treatments: A, tomato stored at room temperature (25±1^{o}C) without acidification; B, acidified tomato (pH=3.2) stored at room temperature (25±1^{o}C); C, tomato stored in a refrigerator (8^{o}C) without acidification; D, acidified tomato (pH=3.2) stored in a refrigerator (8^{o}C); E, tomato stored in an underground silo (19±1^{o}C) without acidification; and F, acidified tomato (pH=3.2) stored in an underground silo (19±1^{o}C). They were evaluated over 60 days, for moisture, titratable acidity soluble solids (^{o}Brix), and lycopene content Data were analysed with R at the 95% confidence level. Moisture ranged from 29.7% to 82.8%, ^{o}Brix 1.9 to 7.1, pH 3.17 to 4.02, titratable acidity 0.2 to 1.9% and lycopene 15.41 to 51.74 μg/g. All treatments of the tomatoes showed stability of its properties. The greatest conservation was with treatments A and B.

Keywords: Tomato; Storage; Conservation and technified processes

1 Introduction

Tomato (*Solanum lycopersicum*) is one of the most universally used fruits. This is due to the different forms of consumption and enjoyment (whole and minimally processed, salads; or processed purees, pasta, powder, ketchup, soup and canned goods), being widely cultivated throughout the world with a total annual production of approximately 186.821 million tonnes in a cultivated area of 5,051,983 hectares (Faostat, 2020). According to Brummell and Harpster (2001), over the past century, the growth in consumption of fresh fruits, in particular whole tomatoes, has led to improvements in conservation treatments to control the proliferation of post-harvest diseases and maintain the fruit quality (or flavour, colour, texture and nutritional parameters) and, consequently, extend its shelf life. These fruits have caught the attention of millions of health seekers according to Soto-Zamora et al. (2005), due to the high levels of vitamins A, E and C, β-carotene (precursor of vitamin A in the human body), fibre and phenolic compounds, namely flavonoids and phenolic acids.

When a fresh fruit is picked, the vital processes

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continue but in a different way. Plants can no longer add food or water, so they have to rely on their stored reserves. When the reserves are depleted, the fruits undergo an ageing process that leads to breakage and deterioration. They will eventually become unacceptable as food because of this natural rot. Tomatoes ripen and deteriorate rapidly at room temperature (20–25^{o}C).

Ochida et al. (2019) refer the use of low temperature storage which decreases rate of respiration, transpiration and thermal decomposition, evaporative cooling of tomato, ethylene treatment, methylcyclopropene (1-MCP), modified atmosphere packaging (MAP), drying and curing as methods that play an important role in extending tomato shelf life.

The conservation of food products aims to extend their shelf life, so that they are available for consumption without affecting the integrity and health of the consumer. Drying is one of the oldest known methods of food preservation, especially for fruits and vegetables. Its use has allowed man to delay the deterioration of biological products, for variable periods, after their physiological maturity (Almeida et al., 2016).

Various forms of treatment and storage are adopted to prevent decay, like freezing, curing and drying (Pinheiro et al., 2013). As described by Adegbola et al. (2012), the basic procedure of drying involves removal of moisture from the fruit to a point where decay is not likely. Drying can be achieved by using an oven, a dehydrator or the warm heat of the sun. Once finished, the produce should be stored in a dry place in airtight containers.

The present study aimed to evaluate the variation of the physicochemical characteristics of tomato under different forms of conservation, in order identify best practice for extending shelf life in storage.

2 Materials and Methods

A survey was conducted to discover the types of tomato storing systems used by smallholders of two different regions, Manica and Cabo Delgado. In Manica province, the survey was conducted in the Gondola district (Inchope and Gondola-sede) while in Cabo Delgado province it was conducted in Pemba-Metuge district (Nacuta and Mieze). According to MAE (2014), Gondola is located in central zone, bordering on the south with the Revué River, which separates it from the Sussundenga district; northeast with the Gorongosa district, east with the Nhamatanda district and at the southeast with the Buzi district. Gondola covers an area of 5,739 km^2 and has an estimated population of 201,735 (Instituto Nacional de Estatística, 2017), a population density of 53.8 habitants/km^2. The population is basically made up of rural families whose main livelihood activity is agriculture. Soils are basically (loam)-clay-sandy, with the main crops being maize, cassava, cowpea, sweet potato and peanuts. In livestock there is a predominance of cattle and swine.

According to MAE (2014), the district of Pemba-Metuge is located 40 km west of the city of Pemba, bordering on the north with the district of Quissanga, on the south with the district of Mecúfi, on the west with the district of Ancuabe and to the east with Pemba city. The district covers an area of 1,594 km^2 and its population was estimated at 89,122 (Instituto Nacional de Estatística, 2017). The population density is approximately 47.3 habitants/km^2 and the soils are basically sandy, washed to moderately washed. In Pemba-Metuge, agriculture is, according to same author, the dominant activity and involves almost all households. It is dominated by the production system based on the cultivation of cassava, intercropped with grain legumes such as cowpeas and peanuts. Livestock activity is complementary to agricultural activity, based on goats, cattle, chickens and ducks. The district has been affected with droughts characterized by irregular and below normal rains, which created a situation of food insecurity, requiring energetic mitigation initiatives from the District Government.

2.1 Local knowledge

Through the qualitative method of rapid ethnography and quantitative post-harvest research (Agbor & Naidoo, 2015), traditional knowledge about agricultural production and conservation methods was recovered in 200 households, where surveys were carried out with key members of the families to identify the basic procedures for the conservation of the most produced crops. Respecting local customs, the technological adjustments were made in stages so as not to compromise the process.

2.2 Experimental procedure

In 5 replications, ripe tomatoes (variety CAL J.), were harvested manually to ensure they were free from physical damage, washed in running water, cut lengthwise in half and the seeds removed. They were then placed in a saline solution (10% NaCl) for 30 minutes, turning every 10 minutes to ensure uniform distribution of the solution, after which the tomatoes were placed on a polyethylene screen (190x180cm) at a height of 1.5 m and dehydrated at room temperature for 58 hours. Then 2 formulations were prepared: (i) by adding acetic acid (pH=3.2) to dehydrated tomato in a 1:1 ratio and (ii) dehydrated tomato with no acetic acid.

2.3 Storage

The treated tomatoes were stored under 3 conditions: room temperature (25±1 ^{o}C), (ii) underground silo (19±1 ^{o}C) and (iii) refrigerator (±8 ^{o}C) for 60 days for periodic verification of quality parameters. For laboratory analysis purposes, 750 g of each formulation were packed in 3 glass pots where (A) was defined as tomato without acidification stored at room temperature, (B), acidified tomato stored at room temperature, (C), tomato without acidification stored in a refrigerator, (D), acidified tomato stored in a refrigerator, (E), tomato without acidification stored in an underground silo and (F), acidified tomato stored in an underground silo.

2.4 Evaluation of physicochemical characteristics

The physicochemical parameters were assessed in triplicate and fortnightly for 60 days.

Moisture Content

It was determined by drying method in an oven at 105 ^{o}C, using 5 g of sample and equation 1 was used to express in percentage, according to AOAC International (2010).

$$Moisture(\%w/w) = \frac{M - M_i}{M} \times 100 \quad (1)$$

Where: M = mass of the sample taken for analysis in grams; Mi = dry sample mass in grams; w/w = weight for weight

Titratable Acidity (TA)

The titratable acidity was determined by the titration method with 0.1 N NaOH, using phenolphthalein as an indicator according to the method reported by Ganje et al. (2016), with the results expressed in % of citric acid, according to equation 2.

$$TA(\%CitricAcid) = \frac{V \times f \times m \times 0.064 \times 100}{p} \quad (2)$$

Where: V = number of mL of sodium hydroxide solution spent in the titration; p = sample mass in g or pipetted volume in mL; m = molarity of the sodium hydroxide solution (0.1 N); f = NaOH correction factor

Soluble solids content (^{o}Brix) and pH

To obtain soluble solids (Brix) a digital refractometer was used (Model 105-d) zeroed with distilled water according to Jafari et al. (2018), then a drop of the homogenised sample was placed on the refractometer for direct reading. To determine the pH, a digital pH-meter, type pH/ORP from HANNA, was used, previously calibrated with pH 7.0 and pH 4.0 buffer solutions; the readings were obtained after the electrode had been immersed in an aqueous suspension of the sample, obtained through crushing the tomato and dispersion in distilled water in the proportion 1:10.

Lycopene contents

Lycopene concentration was obtained spectrophotometrically. Acetone (40 mL) was added to each 5.0 g sample, followed by stirring the mixture for 1 hour using a shaker (TE-1400). Then, the sample was filtered (paper Ø10) to exclude solid particles from the sample. The solids were washed with acetone for 3 more times in order to fully extract the pigments. After addition of 45 mL of petroleum ether, the samples were washed 4 more times to completely remove the acetone. The solution was then transferred to a volumetric flask, the volume made up to 100 mL with petroleum ether and the absorbance read at 470 nm, as suggested by Kakubari et al. (2020). Lycopene contents were estimated from equation 3:

$$Lycopene(\mu g/g) = \frac{(A \times V \times 1000000)}{(CE \times M \times 100)} \quad (3)$$

Where: A = absorbance of the solution at a wavelength of 470 nm, V = final volume of the solution, CE = the extinction coefficient or molar absorptivity coefficient of a pigment in a given specific solvent, M = mass of the sample taken for the analysis.

Statistical analysis

The experiment comprised a 2x3 factorial scheme in a completely randomized block design with 6 treatments, with 2 factors: acidification (2 levels) and storage (3 levels). The results were statistically analysed using analysis of variance (ANOVA) with the statistical package R at the 95% confidence level ($p < 0.05$) to identify significant differences among samples.

3 Results and Discussion

3.1 Survey of local knowledge

Table 1 represents the traditional knowledge and customs of the rural communities of Inchope, Gondola, Nacuta and Mieze on the ways of conservation and storage of tomatoes. Households stored tomatoes in 3 main ways: in polyethylene containers, maize crib and covered by leaves (room temperature). Significant differences ($p \leq 0.05$) were found in the habits and/or customs of conservation and storage in the 4 locations.

The procedures of conservation and/or storage techniques were comprised of harvesting, drying, conservation and storage (Figure 1). In Figure 1, the procedures used locally for conservation are illustrated on the left and the processing with technological adjustments on the right.

In the study carried out by Kitinoja and Kader (2015) with the aim of measuring post-harvest losses of fresh fruits and vegetables in developing countries, it was observed that traditional baskets made of palm leaves and bamboo are commonly used for conservation and management of tomato by most farmers in developing countries. Similar results were also observed in the present study; most households use this material. However, authors such as (Kangire et al., 2016), showed that the use of traditional baskets costs both small and large-scale farmers in local markets post-harvest losses ranging from 30 % - 50 %. This was also observed in the households of the present study. Other authors such as Kereth et al. (2013) and Emana et al. (2017) claim that farmers minimize physical damage to products by smoothing the inner lining of the basket and quickly adding a dampening layer of dry grass. However, grass tends to interrupt air movements, raising the temperature, which severely affects the tomato. Farmers are then recommended to use plastic boxes with holes for proper aeration. Wooden and plastic crates are the other materials that dominate packaging and transport between farmers in developing countries because they are cheap and can be constructed from locally available materials.

3.2 Physicochemical characteristics

Moisture

As shown in Table 2, moisture ranged from 20.3 to 30.78 % for treatment A; 20.3 to 89.93 % for treatment B; 20.3 to 35.6 % for treatment C; 20.3 to 89.11 % for treatment D; 20.3 to 37.43 % for treatment E, 20.3 to 94.24 % for treatment F, being statistically different ($p \leq 0.05$). It remained practically constant for treatments A, B, and a small variation with a tendency to increase for treatments C, E, F and decrease in treatment D, during the following 60 days. It was observed

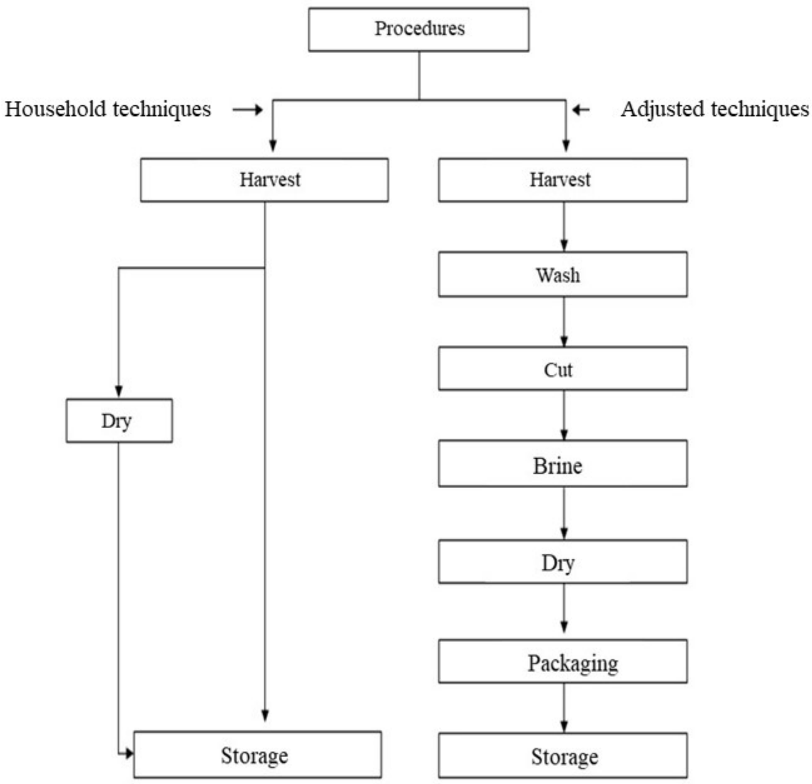

Figure 1: Traditional knowledge about post-harvest treatment of tomatoes in the villages of Inchope, Gondola, Nacuta and Mieze and technological adjustment

Table 1: Storage Systems (Maize crib, Plastic Drum and Room Temperature) used by households for food conservation in the 4 study areas (Nacuta, Mieze, Gondola and Inchope). Plastic Drum values with different superscripts significantly different (P <0.05)

Study areas	Storage systems		
	Maize Crib (%)	Plastic Drum (%)	Room temperature(%)
Mieze	92.00	42.00^{a}	4.00
Nacuta	94.00	56.00^{a}	2.00
Gondola	96.00	4.00^{b}	2.00
Inchope	94	14.00^{b}	-
p-value	*>0.05*	*<0.05*	*>0.05*

that treatments B, D, F had a higher percentage of moisture than the others, which was due to the addition of vinegar. Statistically, the treatments that received the addition of vinegar (B, D, F) were different from the others, presenting an average moisture of 82.81 % and 29.71 % of the remaining ones (A, C, F) respectively.
According to Meloni and Stringueta (2004), the desirable final moisture for dried tomatoes should be between 50 and 55 %. Different values were found in the present study and this variation was due to rehydration of the tomato from the water in the vinegar. So this can be considered a food with sufficient moisture to be consumed without rehydration. In the study carried out by Silva (2016) with the aim of to evaluate the effect of osmotic dehydration (OD), with replacement of sodium chloride (NaCl) by potassium chloride (KCl), followed by drying of the tomatoes, the moisture ranged from 15.91% to 69.49 % in the different treatments with an average of 25 %. The same average range was found in the present study, for the dried tomatoes that did not have the addition of vinegar and that were preserved at room temperature, refrigerated and underground. In the evaluation made by Alessi et al. (2013), storing dehydrated tomatoes in the solar dryer for 90 days, the moisture varied from 42.69 to 43.92 %, values that are above those found in the present study. This difference was due to the difference in solar drying method, which was a greenhouse in the case of Alessi et al. (2013) and in this study it was sunlight.

pH

The pH values are shown in table 2 for treatments A, C and E they ranged from 3.17 to 4.2. In treatments B, D and F the pH values declined in the first 15 days of storage, then stayed approximately constant throughout the remaining days of storage, a fact that is linked to the vinegar added in these treatments. Low pH values were observed in the treatment C reaching 3.17 at 45 days of storage and F reaching 3.16 and 3.17 at 30 and 45 days of storage, respectively. Statistically, the treatments that did not have added vinegar had higher pH values, averaging 3.98 compared to those with added vinegar at 3.55 ($p \leq 0.05$). It was observed that ambient temperature had a different behaviour from storage in refrigeration and in underground silo.
As reported by Silva (2016), it is generally desirable to have a pH lower than 4.5 to reduce the proliferation of microorganisms in the product. The pH in the present study was below 4.5 during the whole 60 days of storage, which would prevent the proliferation of pathogenic microorganisms and inhibit spoilage. In the study carried out by Queji and Pessoa (2011), it was observed that after the drying of Longa Vida tomatoes, the pH was below 4.5., Rodrigues et al. (2008) found that the pH that varied between 4.10 and 4.80 in tomatoes of 25 cultivars. The results of the present study are in agreement with those of Queji and Pessoa (2011).

Contents of total soluble solids

During storage, the dried tomato total soluble solids (TSS) content was significantly influenced by the preservation and the way of packaging. As presented in Table 2, treatment A had a higher value of 6.8 ^{o}Brix after 30 days of storage, as well as treatment C, which showed an increasing ^{o}Brix at 30 and 45 days of storage, with a maximum peak of 7.07 ^{o}Brix. The lowest value was observed in treatment F after 60 days of storage. Treatments A, C, and E had higher values with an average of 4.68 ^{o}Brix, whilst treatments B, D, and F had an average of 3.12 oBrix, these two groups being statistically different ($p \leq 0.05$) Refrigeration maintained the ^{o}Brix at the highest level in relation to the underground silo and ambient temperature, there being no significant difference between these latter two ($p \leq 0.05$).
Similar values were observed in the study carried out by Lacerda et al. (2016) showing a higher value (4.75 ^{o}Brix) of TSS in conventional tomato drying in relation to the other treatments which had an average of 3.77 to 3.92 ^{o}Brix in organic tomatoes. De Araujo (2018) studied the effect of storage in plastic packaging at a refrigerated location and at room temperature on tomato quality and observed that the ^{o}Brix contents of packaged and stored tomato fruits at refrigerated temperature had a lower value compared to post-season fruits, harvest and packaged and stored fruits at room temperature. The same trend was observed in the present study.

Table 2: Variation of physicochemical parameters of tomato, submitted to different forms of conservation, along the storage time (0, 15, 30, 45 and 60 days).

Treatment	**Storage time (days)**	**Moisture (%)**	**pH**	**^{o}Brix**	**Titratable Acidity**	**lycopene (μg/g)**
A	0	20.30 ± 2.61^a	4.15 ± 0.05^a	3.90 ± 0.25^a	0.45 ± 0.03^a	21.52 ± 0.50^a
	15	31.64 ± 0.48^b	4.09 ± 0.04^a	2.23 ± 0.05^a	0.15 ± 0.00^b	47.77 ± 0.45^b
	30	28.23 ± 0.83^b	4.02 ± 0.01^{ab}	6.80 ± 0.00^a	0.43 ± 0.04^d	22.74 ± 0.66^c
	45	30.81 ± 1.34^c	3.87 ± 0.04^a	5.80 ± 0.00^b	0.53 ± 0.03^d	19.39 ± 0.86^c
	60	30.78 ± 1.12^d	3.94 ± 0.05^a	2.23 ± 0.02^e	0.35 ± 0.02^d	16.81 ± 0.78^e
B	0	20.30 ± 2.61^a	4.15 ± 0.05^a	3.90 ± 0.25^a	0.45 ± 0.03^a	21.52 ± 0.50^a
	15	90.65 ± 0.01^a	3.45 ± 0.01^b	3.10 ± 0.00^a	0.38 ± 0.05^a	51.64 ± 0.54^a
	30	91.16 ± 2.32^a	3.39 ± 0.10^c	2.20 ± 0.08^d	1.04 ± 0.01^c	30.77 ± 0.71^b
	45	89.74 ± 0.99^a	3.36 ± 0.03^b	3.57 ± 0.05^d	1.58 ± 0.04^b	30.45 ± 0.68^a
	60	89.93 ± 0.72^b	3.52 ± 0.05^b	4.06 ± 0.02^c	0.89 ± 0.02^c	29.8 ± 0.30^a
C	0	20.30 ± 2.61^a	4.15 ± 0.05^a	3.90 ± 0.25^a	0.45 ± 0.03^a	21.52 ± 0.50^a
	15	33.18 ± 3.79^b	4.01 ± 0.05^a	3.97 ± 0.05^a	0.33 ± 0.01^a	31.28 ± 0.29^d
	30	31.63 ± 0.54^b	3.86 ± 0.13^b	6.83 ± 0.21^a	0.37 ± 0.01^d	16.74 ± 0.40^d
	45	33.13 ± 0.95^{bc}	3.17 ± 0.05^b	7.07 ± 0.09^a	0.53 ± 0.01^d	21.71 ± 0.48^{bc}
	60	35.6 ± 1.06^c	3.98 ± 0.05^a	5.03 ± 0.00^b	0.36 ± 0.01^d	22.93 ± 0.15^{bc}
D	0	20.30 ± 2.61^a	4.15 ± 0.05^a	3.90 ± 0.25^a	0.45 ± 0.03^a	21.52 ± 0.50^a
	15	91.74 ± 1.12^a	3.54 ± 0.07^b	3.13 ± 0.24^a	0.15 ± 0.02^b	33.67 ± 0.15^c
	30	92.13 ± 0.68^a	3.29 ± 0.05^c	2.13 ± 0.19^d	1.22 ± 0.02^b	18.69 ± 0.36^d
	45	90.57 ± 0.83^a	3.87 ± 0.11^a	3.07 ± 0.05^e	1.93 ± 0.05^a	20.08 ± 0.26^c
	60	89.11 ± 0.40^b	3.23 ± 0.00^c	2.80 ± 0.00^d	1.65 ± 0.04^a	23.53 ± 0.43^b
E	0	20.30 ± 2.61^a	4.15 ± 0.05^a	3.90 ± 0.25^a	0.45 ± 0.03^a	21.52 ± 0.50^a
	15	28.97 ± 0.43^b	4.15 ± 0.11^a	3.80 ± 0.08^a	0.33 ± 0.02^a	15.41 ± 1.24^f
	30	27.71 ± 1.51^b	4.14 ± 0.05^a	4.73 ± 0.12^b	0.25 ± 0.02^e	24.79 ± 0.22^b
	45	34.78 ± 0.27^b	4.05 ± 0.08^a	4.30 ± 0.08^c	0.34 ± 0.03^e	20.81 ± 0.27^{bc}
	60	$37.43 \pm 0,80^c$	3.96 ± 0.00^a	5.40 ± 0.01^e	0.36 ± 0.00^d	21.96 ± 0.10^c
F	0	20.30 ± 2.61^a	4.15 ± 0.05^a	3.90 ± 0.25^a	0.45 ± 0.03^a	21.52 ± 0.50^a
	15	91.85 ± 0.21^a	3.30 ± 0.19^b	3.30 ± 0.79^a	0.15 ± 0.01^b	18.82 ± 0.14^e
	30	92.19 ± 0.35^a	3.16 ± 0.05^c	3.23 ± 0.12^c	1.73 ± 0.04^a	47.03 ± 1.78^a
	45	92.61 ± 1.42^a	3.17 ± 0.08^b	2.17 ± 0.12^f	1.50 ± 0.01^c	24.65 ± 2.70^b
	60	94.24 ± 1.29^a	3.26 ± 0.50^c	1.93 ± 0.00^f	1.46 ± 0.03^b	19.48 ± 0.58^d

A, tomato stored at room temperature (25±1 ^{o}C) without acidification; B, acidified tomato (pH=3.2) stored at room temperature (25±1 ^{o}C); C, tomato stored in a refrigerator (8 ^{o}C) without acidification; D, acidified tomato (pH=3.2) stored in a refrigerator (8 ^{o}C); E, tomato stored in an underground silo (19±1 ^{o}C) without acidification; and F, acidified tomato (pH=3.2) stored in an underground silo (19±1 ^{o}C). Means + standard deviation. Values in same column and at same time with differing superscripts gave significant differences in Tukey's LSD test.

Titratable Acidity (TA)

The acidity levels in the treatments ranged from 0.15 to 1.93 %. Treatments B, D, F had the highest acidity values in relation to treatments A, C and E (Table 2). This variation was due to the added vinegar that increased acidity levels. Treatment B had an increase in pH at 30 and 45 days of storage and a decrease at 60 days of storage. The same was observed in treatments D and F. The increase between days 30 and 45 could be attributed to reactions of basic amines that form compounds with low basicity and to the oxidation of alcohols and aldehydes to acids, while for treatments A, C and E there was much less variation, as shown in Figure 1. On average the TA was 0.97% for the treatments that received the addition of vinegar at time zero.
In a study carried out by Abreu et al. (2013) aiming to evaluate the physical and chemical characteristics of canned dried tomatoes, dried tomatoes showed a wide variation of TA from 0.77% to 2.31%. Similar values were found in the present study. Palet (2012) found that there was a slight decrease in acidity from time 0 to 35 days, a slight increase from 35 days to 70 days; similar results were observed in the in the present study. The reduction of acidity may have been due to the loss of organic acids as well as the treatments. Bashir et al. (2014) had variable acidity from 0.21% to 0.45% when evaluating the effects of different drying methods on tomato quality.

Lycopene

Treatment A presented lycopene values from 17 to 48 μg/g, showing a decrease in its contents. This decrease may be associated with the incidence of sunlight. In treatment C, the amount of lycopene ranged from 17 to 31 μg/g and E presented low amounts ranging from 15 to 25 μg/g, with a tendency to increase during 60 days of storage. In treatment B, lycopene levels varied from 22 to 51 μg/g in the first 15 days of storage where the amount of lycopene increased significantly to 51 μg/g and a decline was observed in the 30 days and remained constant at 45 and 60 storage days. In D, lycopene values ranged from 19 to 34 μg/g, the amount of lycopene kept increasing after 45 days of storage (Table 2).

Shi and Le Maguer (2000) indicate isomerization and oxidation as the main causes of degradation of lycopene contents during processing and storage. In turn, the variable retention of lycopene in the treatments during storage was dependent on the presence of lighting, temperature, storage time and the bleaching done during processing. In a study carried out by Srivalli et al. (2017), it was found that there was a gradual decrease in lycopene content during 60 days of tomato powder storage due to isomerization and oxidation. Similar behaviour was observed in the present study.
O'Neill et al. (2001) found 2,718 mg. 100 g^{-1} of lycopene present, higher than found in this work, which may have been due to the varieties used and the agroecological conditions of the local of production.

4 Conclusions

In households there is a greater prevalence in the use of maize crib structures for the conservation of products. The conservation techniques employed by the households in the areas studied do not guarantee the longevity of the tomato's shelf life.
Adjustments to tomato conservation procedures allowed longer tomato shelf life, making it available for more than 60 days in times of lower abundance.
The greatest retention of physicochemical characteristics was found in treatments A, tomato stored at room temperature (25±1^{o}C) without acidification and B, acidified tomato (pH=3.2) stored at room temperature (25±1^{o}C).

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