

# Effect of Stabilizers and Storage Time on the Quality of Tomato Sauce

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**Abstract:** The experiment was conducted at laboratory of the faculty of Agro-industry, Royal University of Agriculture, locating in Phnom Penh city, commenced from August to October, 2023. The single factor CRD (Completely Randomized Design) was used with 6 treatments and 3 replications. While the 7 ingredients were used such as tomato, sugar, salt, onion, bell pepper, sodium benzoate and vinegar, with or without stabilizers. After processing, the sauce was kept in room temperature to observe the self-life and the variation of nutrients contain in 8 weeks. The chemical compositions in the sauce were analyzed to identify the variation during storing in the temperature room. Through the findings showed that the pH value, Total soluble solids and Color (L, A & B) of all treatments has decreased in 8th week comparing to starting point, while the Total acids increased. If comparing among the 6 treatments, after the products have produced (w0), all the chemical compositions in group T0 containing the lowest, exception of Fat and Color (L). When the self-life up to eight weeks, all the composition parameters were statistically different (except for Moisture, Ash, Dry Mass, and Fat). For identification the Bacteria presenting showed that there was no present in first day of self-life until the first week. The present of bacteria were detected from 2nd week to 8th week, excepted T0. The CFU of T0 had the lowest number of colonies, while T3 had the highest once. At the same time, we found that the number of colonies decreases with the age of storage (self-life), which means that at the beginning of growing in the second week, it had higher amount (from 2.10 to 2.69 of CFU as log); while this number decreased with the shelf life up to 8 weeks, which is between 0 to 2.35.

**Key words:** Self-life, chemical compositions, bacteria, CFU.

## 1. Introduction

The agricultural sector contributed about 33.5 percent of GDP in 2009, with the overall growth of the sector averaging 5.4 percent from 2006 to 2009. In the agricultural sector, crop production accounted for more than half in 2009, were 52.9 percent of gross agricultural product [1], the crop production include: mixed crops, industrial crops and fruit trees.

Tomatoes have been cultivated in Cambodia since 1954, originating from Hawaii, with a lifecycle of 90 to 150 days, and farmers prefer to grow along the Mekong River, water channel, lake, pond, around villages and around houses [2]. Tomatoes are consumed worldwide, and represent an important part of the human diet and a

rich source of some nutrients to balance of nutrients in the body, especially lycopene, an enzyme that helps prevent cancer [3], vitamins A, C, E, K and other nutrients [4]. These substances play important role in metabolism to protect the body against certain diseases such as: nervous system, circulatory system and so on. Tomatoes also help strengthen bones, smooth skin, strong hair, prevent heart attacks and make bright eyes.

In Cambodia, Laos and Vietnam, as well as many other countries, Tomatoes can be consumed fresh, but can be processed to different products, including tomato juice, paste, puree, ketchup, and sauces. These products can be sold either as individual products or be included as ingredients in more complex multi-component food products (e.g. Pasta meals). To meet

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consumers quality requirements, some quality parameters of tomato sauce based-products are to be considered very important, such as rheological and appearance indicators (i.e. consistency and Color). It was reported that tomato-based products characterized by a high viscosity and a red Color are preferred by consumers [5, 6]. The quality of tomatoes for processing is determined by the hardness of the fruit, no mechanical damage, no dehydration or spoil. The main reasons for the loss of both quantity and quality during harvest and post-harvest were associated with the improper implementation of harvesting methods, packaging and storage, etc. [7]. In addition, tomatoes can be processed into various products such as: tomato juice, tomato powder, tomato paste or sauce for daily use. However, the quality of tomato sauce depends on the type of ingredients and stabilizers. The stabilizers are: cornstarch, CMC (Carboxymethyl Cellulose) Pectin Carrageenan, which to be used for tomato sauces. In order to promote the awareness of agricultural processing methods and reduce the loss of farmers' produce when tomatoes are abundance, the experimental study was conducted to evaluate the different stabilizers on the production of tomato sauce.

## 2. Material and Methodology

### 2.1 Location, Duration and Experimental Lay Out

The experiment was conducted at laboratory of the faculty of Agro-industry, Royal University of Agriculture, locating in Phnom Penh city. The experiment was commenced August to October, 2023. In the study, the single factor CRD (completely Randomized Design) was use with 6 treatments and 3 replications.

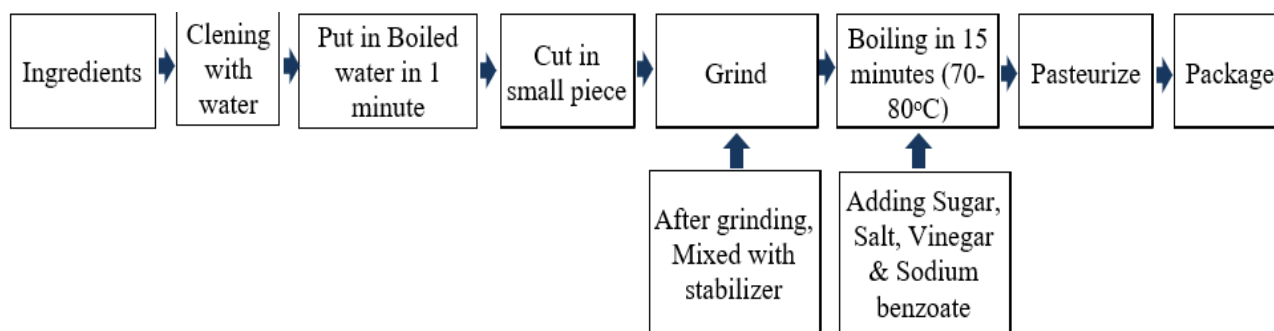


Fig. 1 The processing processes of tomato sauce.

The ingredients use in the formula: Tomato (1000 g) + white sugar (150 g) + Salt (15 g) + Onion (37 g) + Bell Pepper (100 g) + Sodium benzoate (0.7g)+ Vinegar (100 ml)

All the treatment used the same ingredients and formular, excepted the stabilizers, as following:

T0: Without stabilizer,

T1: With stabilizer (Corn powder, 0.4 g),

T2: With stabilizer (Rice powder, 0.4 g),

T3: With stabilizer (CMC, 0.4 g),

T4: With stabilizer (Pectin, 0.4 g),

T5: With stabilizer (Carrageenan, 0.4 g),

After processing, the sauce was kept in room temperature to observe the self-life and the variation of nutrients contain in 8 weeks. The Process of making the sauce showed in Fig. 1.

### 2.2 Data Colection and Chemical Analysis

After processing all the products have been packaged in the small bottle (75 ml) to observe the self-life and chemical analysis from zero week to 8 weeks. The chemical contains were analyzed including Moister, Ash, Total acid, Total soluble solid, Total sugar, Dry matter, Vitamin C, Color, Salt, pH and Fat by following the [8, 9], in addition the bacteria was also counted to identify the total bacteria count.

### 2.3 Data Analysis

All the data were recorded and entered into Excel and all parameters were analyzed by using descriptive and inference statistic formula to identify different significance.

### 3. Result

#### 3.1 The Variation of Some Composition through the Study Period

##### 3.1.1 pH Value

According to Fig. 2, it showed that the values of the six treatments at the beginning and during the eight weeks were similar. In particular, all six treatments had high pH values at the start, which ranged from 4.61 to 4.64, then dropped slightly in the first week and rebounded in the second week. But from the third week, the pH value starts to drop until the eighth week, the last week of the survey, which is in the range of 2.64 to 2.68.

##### 3.1.2 Total Acid

The values of total acid of the treatments, at the beginning and during the eight weeks of follow-up, were similar. In particular, at the beginning, the total acidity of those treatments ranged from 0.39 to 0.45, and in the first to fourth weeks, they seemed to be in fluctuation. But from fifth week, the value of total acid of those treatments began to rise simultaneously until week 8, the last week of the survey, which was higher than in the first week, with the range of 0.42 to 0.54 (Fig. 3).

##### 3.1.3 Total Soluble Solids

The total soluble solids values of the six treatments at the beginning and during the eight weeks of follow-up were similar. In particular, all treatments had high level of total soluble solids at the start (W0), which ranged from 17.70 to 19.30, and then continued to decline gradually until the eighth week, which was the last week of the survey, with values in the range from 15.73 to 16.13 (Fig. 4).

##### 3.1.4 The Variation of Color (L, A and B)

According to Fig. 5 below, the colors of the six products of those treatments at the beginning had similar value. Especially the three-color categories in treatments were gradually declining until the eighth week, in general lower than the level at the beginning.

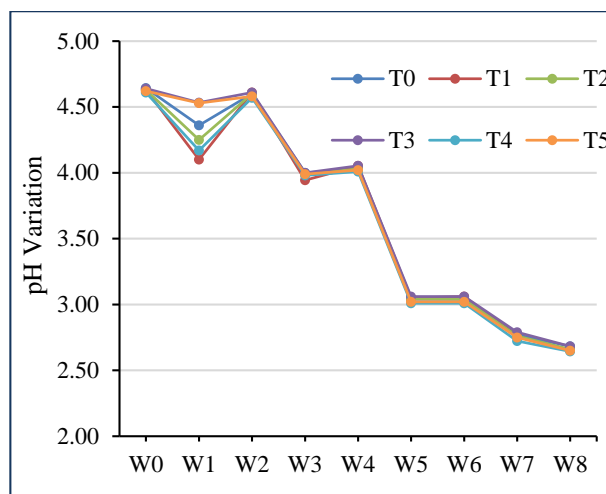


Fig. 2 The pH variation during the 8 weeks.

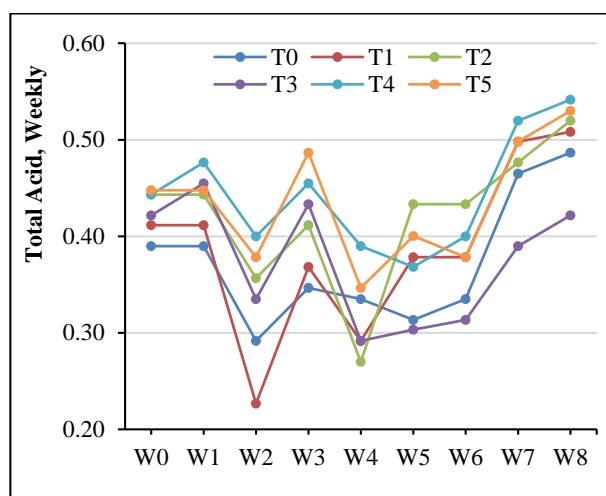


Fig. 3 The variation of total acid during the 8 weeks.

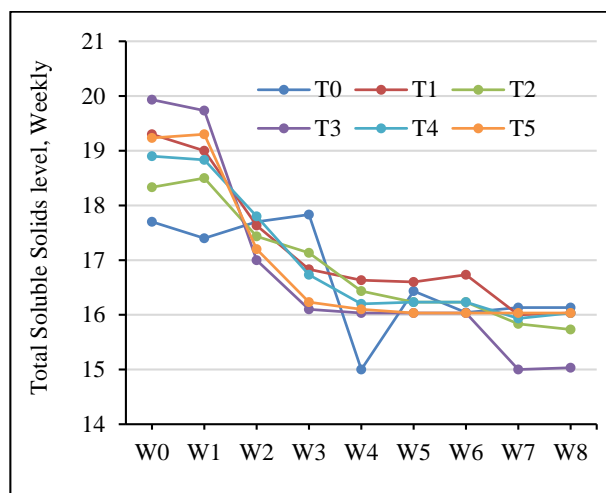


Fig. 4 The variation of total soluble solid during the 8 weeks.

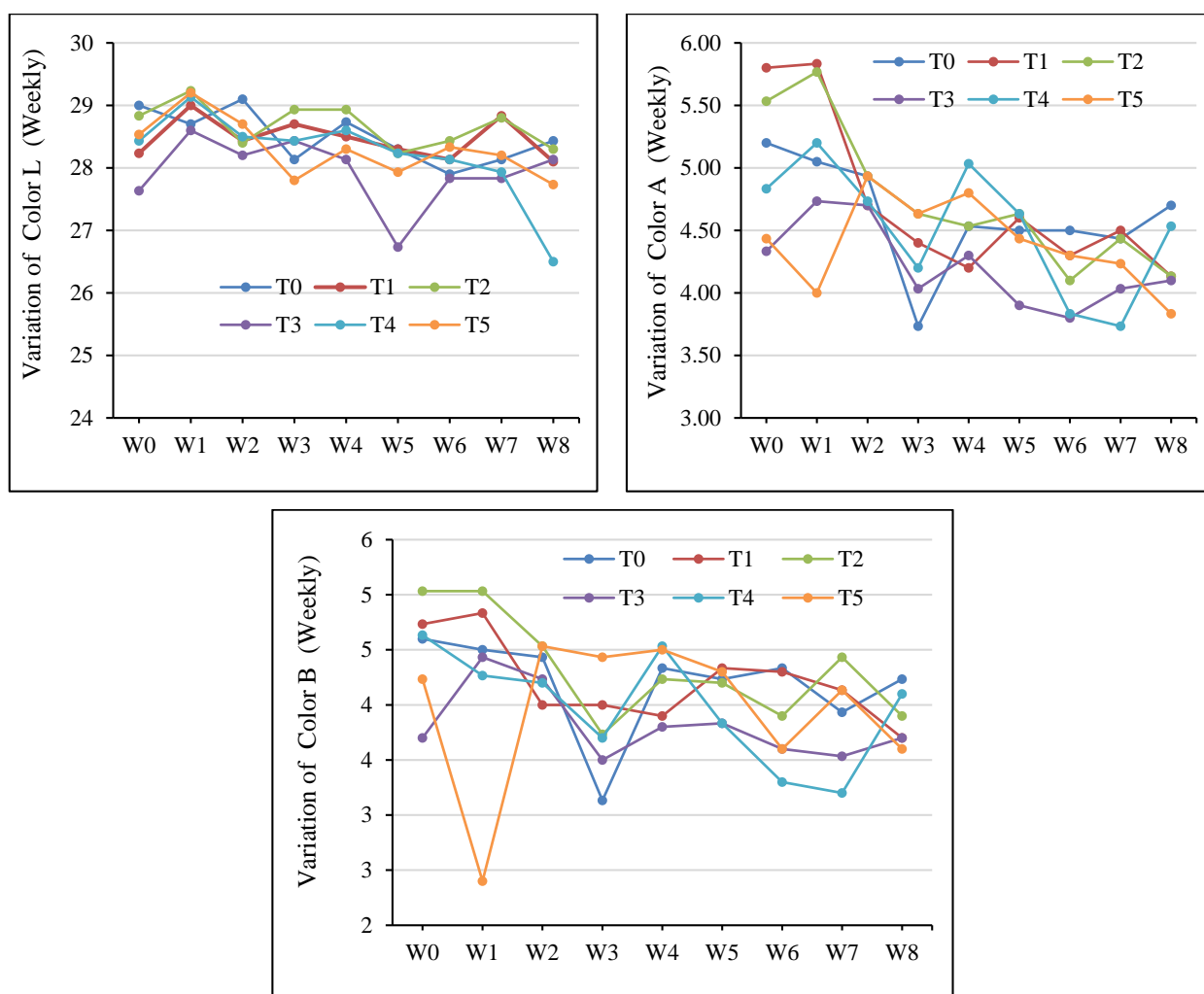


Fig. 5 The variation of the three colors during the 8 weeks.

### 3.2 Chemical Composition

According to Table 1 below, after mixing the ingredients of the sauce, some chemical compounds change according to the formula, including ash, pH, total soluble solids, total sugar, color (L), color (A), color (B), salt and fat. Of these, the T0 group has generally the lowest, with the exception of fat and color (L).

When the product is stored for one week, we see that the values of pH, total acid, total soluble solids and color (L, A, B) of those groups were significant different, and the value of the T0 was generally the lowest, except pH value (Table 2). While for the shelf-life in 2nd weeks, was similar with 1st week, where

those six groups had significant difference, but their level differed from the first week (Table 3).

According to Table 4, when the product is stored for 3 weeks, we see that the values of those compositions in the six groups were different statistically, and the value of the T0 group is generally the lowest (except for pH value and total soluble solids, and this group T0 has the highest).

When the product is stored still 4 and 5 weeks, we found that the values of those compositions in the six groups were different statistically, and that it varies with each parameter among those groups (Tables 5 and 6). The result was also significant different of those compositions among the treatments, at 6 weeks, and those value varied with each parameter (Table 7).

**Table 1 Chemical composition after processing (Day 0).**

<i>Compositions</i>	<i>T0</i>	<i>T1</i>	<i>T2</i>	<i>T3</i>	<i>T4</i>	<i>T5</i>	<i>SE_Mean</i>	<i>p-value</i>
Moisture	83.89	83.46	82.37	80.70	80.70	82.01	1.020	0.204
Ash	1.38	1.50	1.40	1.52	1.39	1.33	0.066	0.003
pH	4.64	4.63	4.63	4.64	4.61	4.62	0.001	< 0.001
Total acid	0.39	0.41	0.44	0.42	0.44	0.45	0.021	0.350
Total soluble solids	17.70	19.30	18.33	19.93	18.90	19.23	0.082	< 0.001
Total sugar	12.92	14.60	15.19	15.58	15.60	16.47	0.158	< 0.001
Dry mass	16.11	16.54	17.63	19.29	19.30	17.99	1.021	0.204
Vitamin C	19.65	23.29	20.38	19.65	19.65	17.47	1.112	0.062
Color (L)	29.00	28.23	28.83	27.63	28.43	28.53	0.232	0.017
Color (A)	5.20	5.80	5.53	4.33	4.83	4.43	0.171	< 0.001
Color (B)	4.60	4.73	5.03	3.70	4.63	4.23	0.247	0.034
Salt	1.17	1.23	1.18	1.21	1.20	1.27	0.015	0.006
Fat	0.22	0.04	0.03	0.01	0.07	0.03	0.008	< 0.001

*Note:* - Significant in row ( $p < 0.05$ ).

- SE Mean: Standard Error of Mean.

**Table 2 Chemical composition after processing (W1).**

<i>Composition</i>	<i>T0</i>	<i>T1</i>	<i>T2</i>	<i>T3</i>	<i>T4</i>	<i>T5</i>	<i>SE</i>	<i>p-value</i>
pH	4.36	4.10	4.25	4.53	4.17	4.53	0.067	0.002
Total acid	0.39	0.41	0.44	0.45	0.48	0.45	0.016	0.024
Total soluble solids	17.40	19.00	18.50	19.73	18.83	19.30	0.038	< 0.001
Color (L)	28.70	29.00	29.23	28.60	29.13	29.20	0.061	< 0.001
Color (A)	5.05	5.83	5.77	4.73	5.20	4.00	0.048	< 0.001
Color (B)	4.50	4.83	5.03	4.43	4.27	2.40	0.059	< 0.001

*Note:* - Significant in row ( $p < 0.05$ ).

- SE Mean: Standard Error of Mean.

**Table 3 Chemical composition after processing (W2).**

<i>Composition</i>	<i>T0</i>	<i>T1</i>	<i>T2</i>	<i>T3</i>	<i>T4</i>	<i>T5</i>	<i>SE Mean</i>	<i>p-value</i>
pH	4.60	4.61	4.60	4.61	4.57	4.58	0.002	0.004
Total acid	0.29	0.23	0.36	0.34	0.40	0.38	0.006	< 0.001
Total soluble solids	17.70	17.63	17.43	17.00	17.80	17.20	0.019	< 0.001
Color (L)	29.10	28.43	28.40	28.20	28.50	28.70	0.116	0.003
Color (A)	4.93	4.70	4.93	4.70	4.73	4.93	0.045	0.010
Color (B)	4.43	4.00	4.53	4.23	4.20	4.53	0.064	< 0.001

*Note:* - Significant in row ( $p < 0.05$ ).

- SE Mean: Standard Error of Mean.

**Table 4 Chemical composition after processing (W3).**

<i>Composition</i>	<i>T0</i>	<i>T1</i>	<i>T2</i>	<i>T3</i>	<i>T4</i>	<i>T5</i>	<i>SE Mean</i>	<i>p-value</i>
pH	4.00	3.94	3.99	4.00	3.98	3.99	0.012	0.050
Total acid	0.35	0.37	0.41	0.43	0.45	0.49	0.006	< 0.001
Total soluble solids	17.83	16.83	17.13	16.10	16.73	16.23	0.031	< 0.001
Color (L)	28.13	28.70	28.93	28.43	28.43	27.80	0.049	< 0.001
Color (A)	3.73	4.40	4.63	4.03	4.20	4.63	0.049	< 0.001
Color (B)	3.13	4.00	3.73	3.50	3.70	4.43	0.230	0.030

*Note:* - Significant in row ( $p < 0.05$ ).

- SE Mean: Standard Error of Mean.

**Table 5 Chemical composition after processing (W4).**

Compositions	T0	T1	T2	T3	T4	T5	SE Mean	p-value
pH	4.03	4.05	4.03	4.05	4.01	4.02	0.020	< 0.001
Total acid	0.34	0.29	0.27	0.29	0.39	0.35	0.007	< 0.001
Total soluble solids	15.00	16.63	16.43	16.03	16.20	16.10	0.033	< 0.001
Color (L)	28.73	28.50	28.93	28.13	28.60	28.30	0.041	< 0.001
Color (A)	4.53	4.20	4.53	4.30	5.03	4.80	0.041	< 0.001
Color (B)	4.33	3.90	4.23	3.80	4.53	4.50	0.024	< 0.001

Note: - Significant in row ( $p < 0.05$ ).

- SE Mean: Standard Error of Mean.

**Table 6 Chemical composition after processing (W5).**

Composition	T0	T1	T2	T3	T4	T5	SE Mean	p-value
pH	3.04	3.05	3.04	3.06	3.01	3.02	0.001	< 0.001
Total acid	0.31	0.38	0.43	0.30	0.37	0.40	0.007	< 0.001
Total soluble solids	16.43	16.60	16.23	16.03	16.23	16.03	0.030	< 0.001
Color (L)	28.30	28.30	28.23	26.73	28.23	27.93	0.064	< 0.001
Color (A)	4.50	4.60	4.63	3.90	4.63	4.43	0.041	< 0.001
Color (B)	4.23	4.33	4.20	3.83	3.83	4.30	0.043	< 0.001

Note: - Significant in row ( $p < 0.05$ ).

- SE Mean: Standard Error of Mean.

**Table 7 Chemical composition after processing (W6).**

Compositions	T0	T1	T2	T3	T4	T5	SE Mean	p-value
pH	3.04	3.06	3.04	3.06	3.01	3.02	0.001	< 0.001
Total acid	0.34	0.38	0.43	0.31	0.40	0.38	0.006	< 0.001
Total soluble solids	16.04	16.73	16.23	16.03	16.23	16.03	0.030	< 0.001
Color (L)	27.90	28.13	28.43	27.83	28.13	28.33	0.056	< 0.001
Color (A)	4.50	4.30	4.10	3.80	3.83	4.30	0.104	0.002
Color (B)	4.33	4.30	3.90	3.60	3.30	3.60	0.054	< 0.001

Note: - Significant in row ( $p < 0.05$ ).

- SE Mean: Standard Error of Mean.

When the product is stored up to 7 weeks, we found that the values of composition in the six groups were different statistically, and it varies with each parameter, with the difference level at  $p < 0.001$  (Table 8).

To store in eight weeks at room temperature, the last week of tracking the shelf-life of those six groups, we found that most of the parameters were statistically different except for moisture, ash, dry mass, and fat (Table 9).

According to Table 10, the level of difference of all compositions in the six product groups between the beginning (W0) and the 8 weeks of shelf life (W8) is as following:

For moisture, total acid, dry mass and fat, those

variations of the compositions among the six groups were not significant different ( $p > 0.05$ ).

While the other remaining compositions are statistically significant, with most of T0 groups having the least variability.

### 3.3 Bacteria Count (CFU/mL)

According to Fig. 6, we found that there was no presence of bacteria on all six groups of products during the W0 to W1. But from the second week of storing onwards, bacteria were present, and the T0 was detected in smallest amount and disappeared in the seventh and eighth weeks, while the other 5 groups were detected until the eighth week.

**Table 8 Chemical composition after processing (W7).**

Composition	T0	T1	T2	T3	T4	T5	SE Mean	p-value
pH	2.77	2.76	2.76	2.79	2.72	2.75	0.003	< 0.001
Total acid	0.46	0.50	0.48	0.39	0.52	0.50	0.003	< 0.001
Total soluble solids	16.13	16.00	15.83	15.00	15.93	16.03	0.027	< 0.001
Color (L)	28.13	28.83	28.80	27.83	27.93	28.20	0.027	< 0.001
Color (A)	4.43	4.50	4.43	4.03	3.73	4.23	0.030	< 0.001
Color (B)	3.93	4.13	4.43	3.53	3.20	4.13	0.038	< 0.001

*Note:* - Significant in row ( $p < 0.05$ ).

- SE Mean: Standard Error of Mean.

**Table 9 Chemical composition after processing (W8).**

Compositions	T0	T1	T2	T3	T4	T5	SE Mean	p-value
Moisture	82.24	82.22	82.69	82.89	82.58	82.31	0.209	0.204
Ash	1.48	1.41	1.40	1.41	1.43	1.41	0.019	0.117
pH	2.68	2.65	2.66	2.68	2.64	2.65	0.003	< 0.001
Total acid	0.49	0.51	0.52	0.42	0.54	0.53	0.005	< 0.001
Total soluble solids	16.13	16.03	15.73	15.03	16.03	16.03	0.033	< 0.001
Total sugar	9.45	10.96	12.54	10.65	10.82	10.92	0.018	< 0.001
Dry mass	17.76	17.78	17.31	17.11	17.42	17.69	0.209	0.204
Vitamin C	19.55	8.74	3.33	6.04	4.68	8.74	0.392	< 0.001
Color (L)	28.43	28.10	28.30	28.13	26.50	27.73	0.053	< 0.001
Color (A)	4.70	4.13	4.13	4.10	4.53	3.83	0.059	< 0.001
Color (B)	4.23	3.70	3.90	3.70	4.10	3.60	0.064	< 0.001
Salt	1.15	1.21	0.89	0.96	1.04	0.78	0.018	< 0.001
Fat	0.23	0.05	0.03	0.52	0.03	0.69	0.207	0.207

*Note:* - Significant in row ( $p < 0.05$ ).

- SE Mean: Standard Error of Mean.

**Table 10 The different between Day 0 and Week 8.**

Compositions	T0	T1	T2	T3	T4	T5	SE Mean	p-value
Moisture	1.65	1.23	-0.33	-2.18	-1.88	-0.30	1.086	0.140
Ash	-0.10	0.09	-0.38	0.11	-0.04	-0.08	0.059	< 0.001
pH	1.96	1.98	1.97	1.96	1.97	1.97	0.002	< 0.001
Total acid	-0.10	-0.10	-0.08	0.00	-0.10	-0.08	0.029	0.071
Total soluble solids	1.57	3.27	2.60	4.90	2.87	3.20	0.100	< 0.001
Total sugar	3.38	3.64	2.65	4.93	4.78	5.56	0.165	< 0.001
Dry mass	-1.65	-1.23	0.33	2.18	1.88	0.30	1.086	0.141
Vitamin C	0.10	14.55	17.05	13.61	14.97	8.73	0.311	< 0.001
Color (L)	0.57	0.13	0.53	-0.50	1.93	0.80	0.278	0.001
Color (A)	0.50	1.67	1.40	0.23	0.30	0.60	0.188	0.001
Color (B)	0.37	1.03	1.13	0.01	0.53	0.63	0.223	0.033
Salt	0.02	0.02	0.29	0.25	0.16	0.49	0.020	< 0.001
Fat	-0.01	-0.02	0.01	-0.51	0.04	-0.65	0.318	0.217

*Note:* - Significant in row ( $p < 0.05$ ).

- SE Mean: Standard Error of Mean.

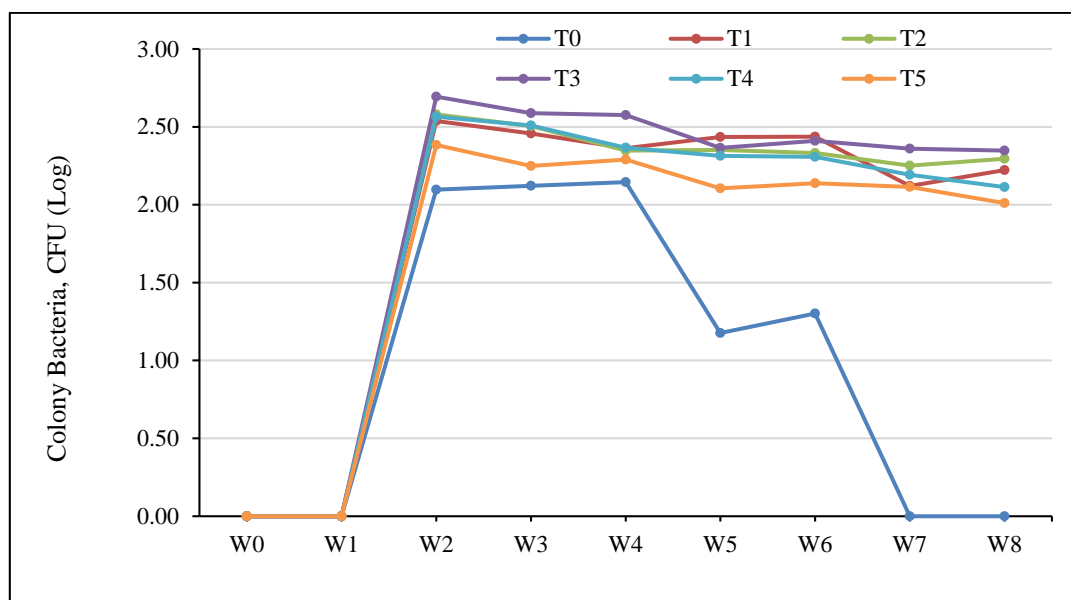


Fig. 6 Bacteria count each week.

Table 11 Bacteria culture (CFU/mL), “Log”.

Week	Unit	T0	T1	T2	T3	T4	T5	SE Mean	p-value
W0	CFU	-	-	-	-	-	-	-	-
	GM	-	-	-	-	-	-	-	-
W1	CFU	-	-	-	-	-	-	-	-
	GM	-	-	-	-	-	-	-	-
W2	CFU	2.10	2.54	2.58	2.69	2.57	2.38	0.016	< 0.001
	GM	125.00	344.96	379.97	494.60	367.42	241.87	-	-
W3	CFU	2.12	2.46	2.15	2.59	2.51	2.25	0.018	< 0.001
	GM	132.29	286.62	319.96	387.49	322.41	177.48	-	-
W4	CFU	2.15	2.36	2.35	2.58	2.37	2.29	0.037	< 0.001
	GM	139.64	230.87	222.37	376.00	232.16	195.00	-	-
W5	CFU	1.18	2.43	2.35	2.37	2.31	2.11	0.048	< 0.001
	GM	15.00	272.21	224.78	231.84	205.91	127.48	-	-
W6	CFU	1.30	2.44	2.33	2.41	2.31	2.14	0.051	< 0.001
	GM	20.00	273.40	214.94	256.90	203.10	137.30	-	-
W7	CFU	-	2.12	2.25	2.36	2.19	2.11	0.046	0.05
	GM	-	131.91	178.26	229.13	155.88	130.00	-	-
W8	CFU	-	2.22	2.30	2.35	2.11	2.01	0.023	< 0.001
	GM	-	166.58	197.48	222.37	129.90	102.47	-	-

CFU: Colony-forming unit; GM: Geometric mean. SE Mean: Standard Error of Mean.

The number of bacterial colonies begins to grow after two weeks of storage, and the six groups had significant difference. The finding showed that every week with bacteria present, the T0 had the lowest number of colonies, while T3 had the highest once. At the same time, we found that the number of colonies decreases with the age of storage (self-life), which

means that at the beginning of growing in the second week, it had higher amount (from 2.10 to 2.69 of CFU as log). This number decreases with the shelf-life up to 8 weeks, which is between 0 and 2.35 (Table 11).

#### 4. Discussion

The bacteria were present in 2nd week of storage,



when pH slightly decreased, it was similar with the previous researcher [8] who found that there was no presence on zero and twentieth day, supported by researcher [9] who stated that the microbial stability of tomato sauce is based on pH (pH lower than 4.0), on pasteurization or addition of preservatives. However, in our finding, CFU/mL, was lower than previous one [8], from 3.4 to 4.6 log CFU/mL. In the finding, pH of 3rd week onwards was lower than the optimum pH for controlling microbial growth [10].

The use of preservatives and chemicals present in the tomato sauce will prolong the shelf-life of the sauce, even storing at the temperature room. However, the freezing could increase the shelf-life of tomato sauce and could be the best choice for storing [9]. In addition, heat treatments affected the shelf-life as well but it could destruct the important nutritive and sensory properties [11].

## 5. Conclusion

The shelf-life of tomatoes sauce is affected by chemical compounds and also bacteria growth. The use of preservative has prolonged the shelf-life of the products, even storing at room temperature.

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