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INFLUENCE OF PACKAGING RESOURCES ON STORAGE STABILITY OF LOCALLY ADMINISTERED TOMATO PASTE

DALATU, I. S[1]., USMAN, M. I[1]., ABBA. B. S[1]. AND ABDULLAHI A. M[1].

Department of Agricultural Engineering Technology, Ramat Polytechnic, Maiduguri

Abstract

The research was piloted at the Postharvest Technology laboratory of Department of Agricultural Engineering Ramat Polytechnic, Maiduguri. The study targeted the influential effect of packaging materials on storage stability of locally administered tomato paste. The packaging materials were bottle with preservative, bottle without preservative, plastic with preservative, plastic without

Keywords

Packaging materials, Storage and Tomato paste

INTRODUCTION

Tomato (*Lycopersicon esculentum L.*) belongs to the family of solanaceae though the site of domestication is uncertain. Peralta and Spooner (2008), suggested that the South West coast of the tropical South America may be ascribed to be the origin of the crop. This crop has become widely grown around the world because of its importance and value (Adepoju, 2014). Tomatoes are grown in most home gardens and commercially as one of the world most popular vegetables. It requires a relatively cool dry climate for high yield and better produce (Nicola *et al*, 2009). It is adapted to a wide range of climatic conditions from temperate to hot and humid tropical.

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preservative, tin with preservative and tin without preservative. Ripe and wholesome tomatoes were procured, sorted and prepared into paste. The quantities of evaporated tomato paste filled into bottle, plastic and tin containers was 371.3 g, and 5 ml of vegetable oil was added as preservative and sealed hermetically. Each packaging materials comprised of six oil treated and six untreated samples totally eighteen samples per replicate and replicated three times and arranged in a Complete Randomized Design (CRD) with total number of fifty-four treatments. Physiochemical analysis was carried out at the end of every month to determine percentage level of dry matter, moisture content, crude protein, crude fiber, fat, ash and carbohydrate content of the treatments for three months. ANOVA was used to determine the variations in nutrient composition in the treatments (packaging materials). The results indicated that nutrients in plastic container without oil preservative were significantly (p<0.05) higher compared to the other packaging materials used and therefore it is recommended for preservation of locally processed tomato paste.

Global tomato production was put at 170.8 million tones, with China accounting for 31% of the total, followed by India and United States with 18.7 and 14.5 million tons respectively as the major producers of tomato in the world (FAOSTAT, 2014). Asia and Africa account for about 79% of the global tomato area under production with about 65% of world output (FAO 2008). Nigeria ranked 16th on the global tomato production; it produces 1.8 million tones accounting for 10.79% of Africa and 1.2% of total world production of tomatoes (Weinberger, 2008). Africa as a continent does not provide enough tomatoes to meet the demand of almost every country in Africa due to its highly perishable nature (FAO, 2008).

Tomatoes are considered to be one of the most economically important crops in the world, being ranked first on their nutritional contribution to human diet. Tomato contained nutrients such as vitamin A, vitamin C, potassium, phosphorus, magnesium and calcium (USDA, 2009). It also

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contained an antioxidant compound called lycopene which are essential to well-balanced human diet and reduces the risk of cancer (Srinivasan, 2010). Tomato cultivation provide tremendous amount of money because they give more yield and it has many advantages over growing other type of crops, such as high yielding potential, short duration crop and suited to different cropping systems (Naika *et al*, 2006).

Packaging is the technology of enclosing or protecting products for distribution, storage, sale and use. It also refers to the process of designing, evaluating, and producing package. Packaging equally describe as a coordinating system of preparing good for transport, warehousing, logistics, sales and end use (Robertson, 2010). Packaging has advantages of assisting in prolonging the shelf life and maintaining quality of tomatoes, it also protects against pathogens, natural predators, and loss of moisture, regulate temperature, provide cushioning effect against deformation and bruising to tomatoes. It helps in reducing the exposure to contaminants in the air and bacteria during handling. Some of the most common packaging materials used for processed tomatoes include; glasses, bottles or jars and tins, cans and polythene. For fresh tomatoes, wooden crates and plastic crates are found to be effective in handling tomatoes.

Locally administered tomatoes are unsafe when used as food because they cause dietary complication like diarrhea and food poisoning. Due to lack of stable storage facilities, locally administered tomatoes can be easily attacked by micro-organisms which causes deterioration of the product, reduce market value and total loss of produce to both producers and consumers.

However, food packaging is an integral and essential part of modern food processing. Effective packaging is a necessity for tomato preservation either fresh or processed. Tomato paste has been in existence for long and it was processed by crushing ripe tomatoes. Fresh tomatoes when properly processed can be preserved for long period and reduce possible spoilage that are caused by agents of deterioration. It also adds value to the produce and makes it available during scarcity and stabilized the high demand of tomatoes and ultimately reduce post-harvest food wastage. Hence, the main objective of this research is to determine the influence of packaging

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resources on storage stability of locally administered tomato paste. The specific objectives are:

i. To determine the most effective packaging material for preserving locally administered tomatoes.
ii. To determine the stability of the locally administered tomato paste.
iii. To determine the physiochemical changes on the stored tomato paste.

MATERIALS AND METHOD

Experimental site

The research was piloted in 2017 between March to May at the Postharvest laboratory of Ramat Polytechnic Maiduguri, Department of Agricultural Engineering Technology Maiduguri, Borno State, Nigeria. The study area is located in the Sudan Savannah belt on Latitude 11°5' N and Longitude 13°3' E. The city stands on some 230 meters above sea level on relatively undulating plains and occupies an area of 50.778km^2. Mean annual rainfall of 1300mm is obtainable and temperature can go as high as 45-48°C between the months of March to May.

Experimental procedure

Some tomato samples were obtained from Gamboru vegetable market Maiduguri, and conveyed to the Post harvest laboratory for processing. The ripe and wholesome tomatoes were sorted and washed thoroughly to remove dirt and contaminants. The washed tomatoes were sliced to convenient size. The excess moisture from the tomato was drained and then the sliced tomato was blended with electrical blender in batches. The blend tomatoes were later evaporated for 4 hours 30 minutes and allow to cool. The treatments consist of four packaging materials (bottles + oil, bottles, plastic + oil, plastic and, tin + oil, tin.) and marked as Bp, Bnp, Pp, Pnp, and Tp,Tnp respectively. The tomato variety used for the experiment was heirloom variety. The empty packaging materials were sterilized and weighed to determine their initial weight before filling with the evaporated tomato paste. The packaging materials were randomly filled with the evaporated tomato paste. The quantity of evaporated tomato paste was poured into bottle, plastic and tin was 371.3 g, and 5 ml of oil was added to

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preserved samples and sealed hermetically. Each packaging materials comprised of six oil treated and six untreated samples totally eighteen samples per replica and replicated three times and arranged in a Completely Randomized Design (CRD) with total number of fifty-four treatments. At the end of every month two oil treated and two untreated samples from each treatment were randomly selected and taken to laboratory for physio-chemical analysis (nutrient contents determination) for period of three months.

Chemical analysis

The tomato samples were analyzed for dry matter, crude protein, crude fiber, ether extract (fat), ash, and carbohydrates according to Association of Official Analytic Chemists, (AOAC) method (1990) 15^{th} edition.

Dry matter

The dry matter content of the tomato samples was determined by weighing 50.02 g of the sample into petri dish and placed into oven and heated for 24 hours up to 105°C, then removed and placed in desiccators to cool, and reweighed. The dry matter content was calculated using the formula;

$$DM = \frac{W_2 - W_3}{W_2 - W_1} \times 100\ \%$$

Where:

DM = Dry matter

W_2 = weight of petri dish with sample in grams before oven dried

W_3 = weight of petri dish with sample in grams after oven dried

W_1 = weight in grams of empty petri dish.

Crude protein

Crude protein content was analyzed using keljdal tablets, 1 g of the sample was weighed and put into a digestion tube and 1 to 2 keljdal tablets was added, then 10 ml of concentrated sulpheric acid (Conc. H_2SO_4) was also added into the tube and digested at 420°C for 4 hours. After cooling, 80 ml of distilled water was added into digested solution. About 50 ml of 40 % caustic soda (NaOH) was also added onto 50 ml of the digested and diluted

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solution and then placed on heating section of the distillation chamber, again 30 ml of 4 % boric acid, plus bromo cresol green and methyl red as an indicator was put into conical flask and placed underneath the distillation chamber for collection of ammonia, the solution changed from orange to green colour. About 0.1 normal solution of hydrochloric acid (Hcl) was measured and poured into the burette. The conical flask containing the solution was titrated until the colour changes from green to pink, then burette reading was recorded. The crude protein was calculated using the formula;

$$\text{Percentage crude protein (CP)} = \frac{A - B \times N \times F \times 6.25}{\text{Mg of samples}} \times 100$$

Where:

A = ml of acid used for titrating the samples

B = ml of acid used for titrating blank sample (O)

N = Normality of acid used for titration

F = Factor = 14.007

6.25 = Constant

100 = Conversion to percentage

Crude fiber

Crude fiber was determined by weighing 2 g of the sample then placed in a round bottom flask, and 50 ml of tri-chloroacetic acid reagent (TCA) was added to the mixture and boiled with refluxed for 40 minutes. Filter paper was used to filter the residue and then removed and cooled to a room temperature. The residue obtained was washed four times with hot water and once with petroleum ether then filter paper plus the sample were folded together and dried at 30°C-60°C in an oven for 24 hours, reweighed and then ash at 650°C, cooled and finally reweighed.

Formula;

$$\text{Percentage crude fiber (CF)} = \frac{\text{Difference in weighing}}{\text{Weight of sample on dried matter (DM) bases}} \times \frac{100}{1}$$

Ash

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To determine the ash content, 1g of the tomato sample was weighed into crucible and dried at 105°C for 24 hours then cooled in desiccators for 15 minutes and reweighed, it was then charred at 600°C in muffle furnace for 2-3 hours, then cooled in desiccators for 15 minutes and reweighed.
Formula;

$$\text{Percentage Ash} = \frac{\text{Loss in weight}}{\text{Initial weight}} \times \frac{100}{1}$$

Carbohydrate
Percentage carbohydrate content was determined by computing indirectly by difference using the formula;
Percentage Carbohydrate = 100 – (% MC + % ash + % CP + % CF).
Where:
% = Percentage, CP = Crude protein, MC = Moisture content, CF = Crude fiber.

Data analysis
Data collected were subjected to analysis of variance (ANOVA) using STATISTIX 8.0 computer package. Duncan's New Multiple Range Test (DMRT) was used to separate the significance means.

RESULTS AND DISCUSSION
Table 1: Influence of packaging materials and oil on dry matter and moisture content of locally processed tomato paste after three months of storage

Treatments	0 month	1st month	2nd month	3rd month
Dry matter (%)				
Bottle (P)	14.90	19.85^{d}	23.55^{d}	23.67^{a}
Bottle (NP)	14.90	18.27^{e}	18.82^{b}	19.67^{c}
Plastic (P)	14.90	20.63^{cd}	30.71^{a}	21.29^{b}
Plastic (NP)	14.90	28.63^{a}	29.89^{a}	22.78^{a}
Tin (P)	14.90	26.72^{b}	27.28^{c}	18.7^{c}
Tin (NP)	14.90	21.47^{c}	27.78	19.78^{c}

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SE± (F-test)		0.4530	0.2859	0.3487
Significant		*	*	*
Moisture content (%)				
Bottle (P)	85.10	81.41^{a}	76.45^{a}	76.45^{c}
Bottle (NP)	85.10	81.10^{ab}	71.17^{c}	80.29^{ab}
Plastic (P)	85.10	79.69^{bc}	69.21^{d}	79.71^{b}
Plastic (NP)	85.10	53.53^{e}	70.11^{d}	77.22^{c}
Tin (P)	85.10	73.27^{d}	72.11^{b}	81.26^{a}
Tin (NP)	85.10	78.52^{c}	72.21^{b}	80.33^{ab}
SE± (F-test)		0.4761	0.3064	0.3792
Significance	*	*	*	*

Means within a column followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT).*= Significant at 5% probability level.

The results in table 1 shows the influence of packaging materials and oil preservation on dry matter and moisture content of locally administered tomato paste after three months of storage. The initial percentage dry matter content of the tomato paste was 14.9%. In the first month of storage significant ($p<0.05$) variation was recorded on the effect of packaging materials on the dry matter content of the tomato paste. Plastic container without oil preservative recorded the highest (28.63%) dry matter followed by tin container with oil preservative (26.72%). The lowest dry matter content was recorded with the bottle container with oil preservative (19.85%). In the second month of storage plastic container with oil preservative recorded the highest (30.71%) dry matter and there are statistically at par with plastic without oil preservative. The least dry matter was obtained with bottle with oil preservative (23.55%). At third month after storage, highest (23.67%) dry matter was recorded with bottle package with oil preservation followed by plastic package without oil preservation. The lowest dry matter was observed with bottle without oil preservative and tin with oil preservative recording 19.67% and 18.7% respectively. The dry matter content increases from the initial month to the second month of storage but drops at third month, these was because

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decrease in moisture content of the tomato paste. The longer the time of storage the higher the dry matter content due to reduction in moisture content of the product.

The initial moisture content of the tomato paste after processing was 85.1%, significant ($p<0.05$) difference was recorded on the influence of packaging materials on moisture content of processed tomato and oil preservation. At first month of storage period, the moisture content decreases from 85.1% to 81.41% in bottle container with oil preservative which also indicates highest level of moisture content compared to other packaging materials. The lowest (53.33%) moisture content was recorded with plastic container without oil preservative. At second month of storage period highest (76.45%) moisture content was recorded with bottle and oil preservative followed by tin container with oil preservative and tin container without oil preservative, while lowest (69.21%) moisture content was found with the plastic container with oil preservative. Moisture content of the stored product at third month was found to be high (81.26%) with tin with oil preservative, followed by tin with preservative recording 80.33%, while the lowest (76.45%) moisture content was recorded with bottle container with oil preservative. This results were in agreement with the findings of Famurew (2013), on his work storage stability of tomato paste package in plastic bottle and polythene stored.

Table 2: Influence of packaging materials and oil on crude protein and fat of locally processed tomato paste after three months of storage

Treatments	0 month	1st month	2nd month	3rd month
Crude protein (%)				
Bottle (P)	8.66	7.62^{a}	7.87^{b}	6.95^{c}
Bottle (NP)	8.66	6.83^{a}	9.01^{a}	9.23^{a}
Plastic (P)	8.66	7.58^{b}	2.33^{d}	8.13^{b}
Plastic (NP)	8.66	5.36^{b}	7.33^{bc}	9.49^{a}
Tin (P)	8.66	5.05^{b}	7.70^{bc}	6.05^{d}
TIN (NP)	8.66	5.58^{b}	6.62^{c}	5.59^{d}
SE±(F-Test)		0.2886	0.3438	0.2622
Significance		*	*	*

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		Fat (%)		
Bottle (P)	1.0	2.33^{c}	1.00^{d}	2.33^{b}
Bottle (NP)	1.0	4.66^{b}	4.00^{b}	1.00^{d}
Plastic (P)	1.0	2.00^{c}	2.33^{c}	1.60^{c}
Plastic (NP)	1.0	9.66^{a}	7.33^{a}	4.66^{a}
Tin (P)	1.0	2.00^{c}	1.66^{cd}	2.00^{bc}
\TIN (NP)	1.0	2.66^{c}	2.00^{c}	5.00^{a}
SE±(F-Test)		0.2722	0.2277	0.2018
Significance		*	*	*

Means within a column followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT).

*= Significant at 5% probability level.

The results in table 2, represent the influence of packaging materials and oil preservation on crude protein and fat content of locally administered tomato paste after three months of storage. The initial percentage crude protein content of tomato paste was 8.66%. In the first month of storage period significant ($p<0.05$) variation was recorded on the influence of packaging materials on crude protein content of the tomato paste, bottle container with oil preservative recorded the highest (7.62%) crude protein followed by plastic container with oil preservative (7.58%). Tin container with preservative recorded the lowest crude protein (5.05%). In the second month of storage, bottle container without oil preservative recorded the highest (9.01%) crude protein content followed by bottle container with oil preservative (7.87%), while plastic container with preservative (2.33%) recorded the lowest content of crude protein. In the third month plastic container without oil preservation recorded the highest (9.49%) crude protein content followed by bottle container without preservation (9.23%) and tin container without preservative recorded the least crude protein (5.59%).

The initial fat content of the tomato paste at the initial month was 1.0%, significant ($p<0.05$) effect was recorded on the influence of packaging materials on fat content of processed tomato and oil preservation. At the

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end of first month plastic container without oil preservative recorded the highest (9.66%) fat content this shows that the fat content increase by 10 folds, then followed by bottle container without preservative with 4.66% and the lowest (2.0%) fat content was recorded by both plastic container and tin container with oil preservative. In the second month, plastic container without oil preservative recorded highest (7.33%) fat content followed by bottle container without oil preservative (4.0%), and bottle container with oil preservative recorded the lowest (1.0%) fat content, while in the third month, tin container without oil preservative recorded the highest (5.0%) fat content, while plastic container without oil preservative followed (4.66%) and bottle without oil preservative recorded the least (1.0%) fat content. This coincided with the work of Ibidapo (2013), on storage stability of tomato paste package in bottle and polythene stored.

Table 3: Influence of packaging materials and oil on crude protein and fat of locally processed tomato paste after three months of storage

Treatments	0 month	1st month	2nd month	3rd month
Crude fiber (%)				
Bottle (P)	20.0	18.66^{c}	16.66^{e}	24.33^{e}
Bottle (NP)	20.0	24.66^{b}	22.00^{a}	21.66^{c}
Plastic (P)	20.00	27.00^{a}	20.00^{b}	22.66^{c}
Plastic (NP)	20.00	23.66^{b}	22.00^{a}	26.33^{a}
Tin (P)	20.00	23.66^{b}	17.66^{d}	22.00^{c}
TIN (NP)	20.00	24.33^{b}	19.00^{c}	24.00^{b}
SE±(F-Test)		0.4082	0.2509	0.3801
Significance		*	*	*
		Ash (%)		
Bottle (P)	5.0	2.00^{c}	3.33^{c}	3.33^{ab}
Bottle (NP)	5.0	2.66^{b}	3.33^{c}	3.00^{ab}
Plastic (P)	5.0	$3.0a^{b}$	3.33^{c}	3.00^{ab}
Plastic (NP)	5.0	1.00^{d}	4.66^{b}	2.66^{b}
Tin (P)	5.0	3.33^{a}	5.00^{b}	3.33^{ab}

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TIN (NP)	5.0	2.00[c]	6.33[a]	3.66[a]
SE±(F-Test)		0.1826	0.3801	0.2789
Significance		*	*	*

Means within a column followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT). *= Significant at 5% probability level.

The results in table 3 indicates the influence of packaging materials and oil preservation on crude fiber and ash content of locally administered tomato paste after three month of storage. The initial percentage crude fiber at zero month was (20.0%). In the first month of storage significant ($p<0.05$) variation was recorded on the influence of packaging materials on crude fiber content of the tomato paste. Plastic container with oil preservative recorded the highest (27.0%) crude fiber indicating an increase of 7%, then followed by bottle container without oil preservative (24.66%). The lowest crude fiber content was recorded with the bottle container with oil preservative (18.66%). In the second month both bottle and plastic without oil preservative recorded the highest (22.0%) crude fiber content, while plastic container with oil preservative followed with (20.0%) and the lowest crude fiber content was recorded with bottle container with oil preservative (16.66%). At the end of the third month highest (26.66%) crude fiber was recorded with plastic container without oil preservative followed by bottle container with oil preservative while bottle container without oil preservative recorded lowest (21.66%) of crude fiber content.
The initial ash content of the tomato paste at zero month after processing was (5%). Significant ($p<0.05$) effect was recorded on the influence of packaging materials on ash content of locally processed tomato and oil preservation. In the first month of storage period, the ash content decreases from 5.0% to 3.33% in tin container with oil preservative which also indicates the highest level of ash content compared to other packaging resources, followed by plastic container with oil preservative (3.0%) and the lowest (1.0%) ash content was recorded with plastic container without oil preservatives. While at the second month of storage period the ash content increases to 6.33% with tin-container without oil preservative while bottle container without oil preservative, bottle container with oil

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preservative and plastic container with oil preservative all reflected decrease (3.33%) in ash content. Ash content of the stored tomato paste in the third month of storage also dropped (3.66%) with tin container without oil preservative, followed by both tin-container with oil preservative and bottle container with oil preservative with 3.33% ash content, and plastic container without oil preservative recorded the lowest (2.66%) ash content. This results were in support of findings of Smith and Hul (2004), on food processing.

Table 4: Influence of packaging materials and oil on carbohydrate content of locally processed tomato paste after three months of storage

Treatments	0 month	1st month	2nd month	3rd month
		Carbohydrate (%)		
Bottle (P)	18.76	30.62[c]	31.94[c]	14.27[c]
Bottle (NP)	18.76	38.83[b]	34.28[b]	14.12[c]
Plastic (P)	18.76	39.58[b]	34.98[b]	20.47[a]
Plastic (NP)	18.76	41.69[a]	40.64[a]	16.34[b]
Tin (P)	18.76	34.05[c]	31.94[c]	12.98[d]
TIN (NP)	18.76	34.58[c]	34.28[b]	13.60[cd]
SE±(F-Test)		0.3552	0.3702	0.2837
Significance		*	*	*

Means within a column followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT). *= Significant at 5% probability level.

The results in table 4, represent the influence of packaging materials and oil preservative on carbohydrate content of locally administered tomato paste after three months of storage. The initial percentage carbohydrate content at 0 month was 18.76%. At the end of the first month, significant ($p<0.05$) variation was recorded on the influence of packaging resources on carbohydrate content of tomato paste. Plastic container without oil preservative recorded the highest (41.69%) carbohydrate content indicating significant increase by more than two folds followed by plastic container with oil preservative recording 39.58%. The lowest (30.62%)

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carbohydrate content was recorded with bottle container with oil preservatives. At the end of second month, the highest (40.64%) carbohydrate content was recorded with plastic container without oil preservative followed by plastic container with oil preservative and bottle and tin container with oil preservative recorded the least (31.94%) carbohydrate content each. At the end of third month, highest (20.47%) carbohydrate content was recorded with plastic container with oil preservative and followed by plastic container without oil preservative 16.34%. The least (12.98%) carbohydrate content was recorded with tin container with oil preservative. The results were in support with the findings of Okorie and Okoro (2004), on their work on the quality properties of tomatoes as influence by processing with preservative and storage recording similar range of carbohydrate content after processing and storing tomato paste.

Summary

The research aimed at determining the influence of packaging materials on storage stability of locally administered tomato paste using different packaging resources (bottle, plastic and tin) with vegetable oil as preservative agent and stored for periods of 3 months. At the end of every month, samples were collected from all the treatments and analyzed for nutrient composition, the results of the experiment show that dry matter, crude protein, fat, crude fiber and carbohydrate where high with plastic container as packaging materials recorded 28.6, 9.49, 9.66, 26.33 and 41.69 % respectively. It indicates bottle container (packaging resources) retain the lowest dry matter, moisture content, fat, crude fiber, ash and carbohydrate having 23.5, 76.4, 1.0, 18.6, 3.33 and 30.62 % respectively. The results show that the plastic container indicates superiority compared to other packaging resources used.

CONCLUSION

The results of the experiment represent that plastic packaging resources without oil preservative provided the most convenient environment for preservation of locally administered tomato paste because it retained almost all the important nutrient in their highest levels compared to other

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packaging resources used (bottle, and tin). Consequently, tin packaging material was found to be less effective in preserving locally administered tomatoes because, it was not sealed hermetically like other packaging resources (bottles and plastic) which lead to infection by microorganism, thereby creating favorable conditions for the survival of microorganisms.

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