

NATURE OF TOMATOES MICROFLORA UNDER STORAGE

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Abstract

Tomato scientifically known as *Solanum lycopersicum* is widely cultivated and consumed in various part of the world. Tomato leaves and stems actually contain poisonous glycoalkaloids, but the fruit is safe. Various species of microorganism can alter adversely the nutritional quality of tomatoes. Microorganisms that cause spoilage like moulds, yeast and bacteria are destroyed by heat processing based on comparative analysis of this study. In tomato, the lactic acid bacteria are the major natural microflora of this products due to the high acidic composition of the fruit which depicts the major reason while the product (tomato) usually ferment lactose sugar to give lactic acid hence botulism will not thrive under this condition. The study shows the various types of microorganisms encountered in tomatoes and canned tomato product analyzed in the laboratory. The organisms that were isolated include eight bacteria species such as, *Staphylococcus species*, *Planococcus species*, *Micrococcus Species*, *Bacillus Species*, *Streptococcus Species*, *Leuconostoc Species*, *Pediococcus species* and *Clostridium specie*. Similarly, three fungal species were encountered during the study. These include *Saccharomyces species*, *Aspergillus species* and *Neurospora species*. This study shows that substantive amount of spoilage microorganisms were isolated from raw (local) tomatoes than those isolated from the canned tomatoes thus giving an assurance of canning as a good means of preserving foods such as tomatoes through adequate heat treatment for a long period of time as stipulated by the shelf life. Similarly, the nature of microorganism encountered can be used to determine some preservative measures.

Keywords: Microflora, Storage, Tomatoes, Nutrients

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30 Introduction and literature review

31 Tomato scientifically known as *Solanum lycopersicum*, is a herbaceous plant usually sprawling
32 on ground in the solanacea family. They are close family to tobacco, chill peppers and egg plant.
33 It is a perennial often grown outdoors in temperate climate as an annual, typically reaching to 1-
34 3m) (3-10feet) in height, weak woody stem that often vines over other plants (Jay 1976). Tomato
35 is widely used as condiment or as food dietary supplement in various part of the world. It is also
36 valuable in the food industry (Njoku, 1991).

37 The tomato is a native to central north and southern North America from Mexico to
38 Argentina. There is evidence that the first domesticated tomato was a little yellow fruit ancestor
39 of *L. ceraciforme*, grown by the Aztecs in Mexico who called it xitomat (pronounced shi-to-ma-
40 th) meaning plump thing with a navel. The word tomato comes from a word in the Nahuatt
41 language tomatt. The specific name, *Lycopersicum* means “wolf peach” (compare the related
42 specie, *Solanum lycopersicum* whose specific name means “wolf fruit”. Common name “wolf
43 apple” and they are a major food of wild canids in South America (Jay, 1976).

44 Tomatos were not grown in England until the 1590s according to smith. One of the
45 earliest cultivars was John Gerad, a barber surgeon. Gerad’s herbal published in 1597 and largely
46 plagiarized from continental sources is also one of the earliest sources of tomatoes in England.
47 Gerad knew that the tomato was eaten in Spain and Italy. Nonetheless, he believed that it was
48 poisonous. Tomato leaves and stems actually contain poisonous glycoalkaloids, but the fruit is
49 safe. Gerad’s view were influential and the tomato was considered unfit for eating (though not
50 necessarily poisonous) for many years in Britain and its North American colonies (Gerad, 1598)

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58 Various species of microorganism can alter adversely the nutritional quality of tomatoes.
59 Microorganisms that cause spoilage like moulds, yeast and bacteria are destroyed by heat
60 processing. Both raw and processed tomato and tomato products were directly associated with
61 plasma lycopene concentrate with association being strongest for processed tomato and products.
62 Plasma lycopene concentrations are controlled by a wide range of factors by which dietary intake
63 is only one study of the complex relation between diet circulating nutrients and diseases.
64 Outcome will help to defend most desirable dietary choices for vulnerable population groups
65 such as the elderly (Buchann, 2008).

66 Several factors that influence the preservation process and quality time and temperature
67 required include the Composition of other vegetable or meat added (acidity); Composition of
68 other tomatoes (acidity, solid content); Style of tomato preparation(crushed, whole or halved);
69 Type of liquid added to tomatoes (juice water none); Consistency of tomato products(thick, thin);
70 Initial temperature(hot or raw pack); Type of jar (size, shape) and the type of jar (size, shape)
71 (Redlinger, 2007).

72 Processing times are scientifically determined. Therefore it is extremely important to follow
73 a tested recipe for tomato and tomato products (such as salse), changing the amount or type of
74 ingredients and methods of preparation can influence the processing conditions needed to
75 guarantee safety. Example adding extra vegetable to a salsa recipe can change acidity and
76 overcooking can change consistency. Products that are prepared according to instructions should
77 be frozen. (Herson *et. al.*, 1981)

78 Preservation of Tomato by Canning

79 Canning is a process of hermetically sealing cooked food for future use. It is a
80 preservation method in which prepared glass jars or metal cans that are hermetically sealed to
81 keep out air and then heated to a specific temperature at specified time to destroy disease causing
82 microorganisms and prevent spoilage. Low acid foods such as peas, corn, poultry etc heated to

240⁰-265⁰F (116⁰-129⁰C) while acidic foods such as fruits are heated to about 212⁰F 100⁰C)
(Nicholas, 1809).

Tomato can be needed for some specialized conditions to strengthen health. And because of the food requirements of soldiers during the US census, considerable amount of canned meats and vegetables including tomatoes were produced (Salmon, 1987). Highly specialized machinery, knowledgeable of bacteriology as well as more efficient process of cooking has combined to make the commercial canning of food an important feature of modern life. The range of products canned has increased enormously and includes; meat and vegetables; seafood; milk, jams, pickles and sauces.

The general principle of food and home canning are the same but the factory more accurately controls procedures and has highly specialized machinery. The Mason jar popular in most home canning was patented in 1858. Home canning grew in population in World War II when the harvest of victory gardens was canned. Canning leads to a loss of nutrient particularly of the water-soluble vitamins. The home canning methods which are no longer considered safe (Andres, 2006)

Canned tomato are tomatoes that are usually peeled, that are seeded into a can after having been processed by plum tomatoes such as Roma or San Marzano are the most common choice of canning since they have equal solid to liquid ratio than other tomatoes and make a more substantial canned products. Commercial canners use tomato which has a more firm outer peel and pectin layer. They are available in several different forms, the traditional form are whole peeled tomato juice or puree (taste test indicate that those packed in juice tend to be perceived in fresher-tasting) and sometimes referred to as “kitchen ready” and not to be confused with puree which is similar but more common in crushed tomatoes, commonly used for pasta sauce, are made by adding the general tomato to a heavy amount from tomato paste.

In areas and situations where in season, perfectly ripe tomatoes are not available, canned tomato are of alternative to prepare dishes such as sauce or pizza. The top uses of caned tomato are in Italian, chill, soup, pizza, stew, casseroles and Mexican dishes. Industrially prepared canned tomato may be prepared in a number of ways. However safety measures need to be taken because imperfectly canned tomato can cause botulism poisoning (Herson and Hullard, 1989).

Over the years, tomato canning recommendation have changed as a result of new research findings. In 1987, the US department of agriculture completed extensive testing of tomato canning procedure. On the basis of this research, several changes have been made to ensure that home canned tomato product will be save to eat and can be stored on the shelf without spoiling this procedures have been adopted nationwide (Andres, 2006)

Processing times have been lengthened to ensure that tomato varieties with a high solid content will be adequately processed.

Firm under ripe to ripe tomatoes should be selected for preparation. Use of decayed or overripe tomatoes may result in spoilage of canned products. Tomatoes from dead or frost killed vines should not be canned. Similarly, the tomatoes should be washed in cool running waters. To can crush, whole or halved tomato, the skins has to be removed by dipping in boiling water for 30 seconds or until skin splits. Dip in cold water, slip off skins and remove cores. Yields may vary. The amount generally needed per quart will be based on the type whether it is crushed tomatoes, whole or halved tomato juice or tomato sauce (Field, 1970).

In packing and closing the jars, either hot pack or raw pack directions should be followed. In the hot pack methods, food is packed in the jars while still very hot. Then the cooking liquid or boiling water is added in the raw pack method, raw food is packed in the jars and covered with boiling water or juice. The hot pack method has several advantages. Healed tomatoes are easier to pack into jars because they are softer. As a result, more can be put into jars, fewer jars are needed and tomatoes float less. However raw packed tomatoes will be firmer in texture. In packing of the jars some process involved includes adding acid as an extra measure to prevent spoilage and adding salt to tomatoes or flavor not to preserve them (Adams, 1998).

Temperature higher than 212⁰F is required to destroy the spores of *Clostridium botulinum* in low acids foods which includes; vegetable, red meat, poultry, fish and wider game. To reach temperature higher the boiling point of water (212⁰F), a pressure canner can be used. The temperature of at least 240⁰F is needed for the destruction of *clostridium botulinum* spores. Therefore canning of low acid food is done in the pressure canner at 10 or 11 pounds of pressure (240⁰F) or at 15 pounds of pressure (250⁰F). Adjustment in canner pressure made according to elevation made above sea level (Herson and Hullard, 1989).

Some safety precautions should be observed during production process to enhance preservation. The only safe way to can food at home is to match the food product to the correct method, use safe recipes and follow the recommended procedure. Spoilage can be prevented in home canned product by adequate heat processing foods in a boiling water, bath or steam pressure canner for a specified period of time. The method used for processing depends on whether the food is high or low acid. For safety, use approved recipe that are based on scientific principles. Any practice that does not involve adequate processing may be potentially dangerous and should be avoided (Schmitt *et. al.*, 1996).

Tomato products have some nutritional benefits for human health which gives it some unique attributes. Tomato juice is used and could be taken to prevent blood clot. About one cup of tomato juice per day offers the anti-clotting benefits. Red raw tomatoes has the following values; Nutritional value for-100 g it composes, Energy 20Kcal-80 KJ, Carbohydrates- 4g, Sugar-2.6g, Dietary fiber-1g, Fat-0.2g, Proteins-1g, Vitamin C (13mg)-22% and Water 95g. Other components include natural Lycopene which is a red fat soluble pigment found in vegetable commonly found in tomatoes which also add to its nutritive value. Tomato products also offer important nutrients like vitamin A, vitamin C, potassium and fiber. You don't have to worry about botulism in home canned tomatoes because tomatoes are too acidic for bacteria growth (Herson and Hullard, 1989).

The natural microflora of vegetables such as tomatoes includes; bacteria, yeast, and certain fungi group which includes some molds species like *Aspergillus* (Smith *et. al* 1952). In tomato, the lactic acid bacteria are the major natural microflora of this products due to the high acidic composition of the fruit which depicts the major reason while the product (tomato) usually ferment lactose sugar to give lactic acid. Also, yeast cells such as *Saccharomyces cerearisa*e also due to its acidity. Other microorganisms found in tomato are not its rich composition (Herson and Hullard, 1989). Examples of the lactic acid bacteria in tomato are *Leuconostoc specie* and *Lactobacillus specie*. These bacterial species are its natural flora (Mabbitt and Mossel, 1967).

Under processing of canned foods result in spoilage by thermophilic bacteria and the three types of thermophiles are, Flat sour, Thermophilic acid (TA) spoilage and Sulphide spoilage.

169 In flat sour, the ends of the can remain flat and spoilage cannot be detected unless can is
170 opened. The spoilage occurs in low acid foods and is caused by thermophilic species of bacillus
171 such as *Bacillus coagulans* and *Bacillus sterothermophiles*. These organisms produce acid
172 without gas. The thermophilic acid (TA) spoilage, the can swells due to production of
173 carbondioxide (CO₂) and hydrogen (H₂) by *Clostridium thermosaccharolyticum* an obligate
174 thermophile and therefore needs hot storage for its development.

175 Sulphide spoilage (sulphur stinker) is caused by *Clostridium nigrifican* in low acid foods.
176 Spore of these bacteria are not very heat sensitive and their appearance is an indication of under
177 processing. Spoilage is indicated by the presence of hydrogen sulphide (H₂S) and blackening of
178 the bacteria. Sources of all these organisms are generally; the plant equipment, sugar, starch and
179 other material or soil (Ayres *et. al*, 1998)

180 Spoilage of canned foods can also largely result from mesophilic organisms and is
181 indicative of under processing and is caused by species of *Bacillus*, *Clostridium*, yeast and fungi.
182 *Clostridium butyricum* and *Clostridium pasteurianum* produce a butyric acid type of
183 fermentation in acid or medium acid foods with swelling of the container by the production of
184 carbondioxide (CO₂) and hydrogen (H₂). Other species of *Clostridia* may produce hydrogen
185 sulphide and other malodorous compounds causing the can to swell. These putrefactive
186 anaerobes generally grow in low acid foods such as peas, corn, meat, poultry and others but
187 sometimes may also spoil medium acid foods. Some Bacilli such as *Bacillus subtilis* and *Bacillus*
188 *mesentroides* have been found to grow in poorly evacuated cans of sea foods, meat and milk.
189 *Salmonella* and other pathogens are killed at 145⁰C (Herson and Hullard, 1989)

190 After a food has been canned it must be heated to eliminate the risk of botulism arising
191 from *Clostridium botulinum* spores. Heat treatment is carried long enough to reduce the
192 population of 10¹²C Botulinum spores to 10⁰ (one spore) thus there is a very small chance of any
193 can having a viable spore (Prescott *et. al.*, 2008).

195 Materials and Methods

196 Sterilization of Materials and Media Preparation

The materials used for this study were sterilized by appropriate methods to free them from microbial contamination. All the media used were sterilized at 121⁰C for 15minutes in an autoclave and were prepared according to the manufacturers' instruction or standard methods for examination of water (APHA 1998). Culture media generally use for the study are nutrient agar and potato dextrose agar (PDA). All glass ware was sterilized in the hot air oven at 160⁰C for two hours. The inoculating needle and wire were sterilized by flaming in the Bunsen burner until red hot, working surface were sterilized by the application of disinfectants/antiseptic solutions (95% ethanol).

Sample Collection

Selected canned tomatoes were purchased from various areas from Ondo State. These include Ciao toma, Tasty tom, Petti and Titus. The local tomato that was used as the control sample was also purchased in a local market in Akungba Akoko, Ondo State, Nigeria. All samples were taken to the laboratory immediately after purchase. During the collection of the samples, the observations made were that some of the canned tomatoes were rusted and others had their cans intact without rusts. The local tomatoes use ensured spoilage free at the point of collection.

Sample Preservation

The samples were preserved in the refrigerator at 4⁰C after opening the can. This was meant to generally slow down biological activities and reduce chemical reaction

Isolation of Microbes from the Study Samples

Serial dilution of each sample was carried out by pipetting 1mL of the sample into 9mL of sterile distilled water in McCartney bottles to give 10⁻¹ dilution. Further dilution was made to give higher dilutions as required. For each samples after series dilution, 0.1ml and 1ml was taken from 10⁻², 10⁻³, 10⁻⁵ dilution into a sterile plate.

The sterilized medium of nutrient agar (NA) and the potato dextrose agar (PDA) generally used during the study were poured in the plate already containing the diluents as appropriate using the method known as pour plate technique. This was then swirled evenly to make the mixture homogenized and left for few minute(s) to allow it to solidify. The inoculated

plates were labeled properly for easy identification, and then the plate was incubated for 37⁰C for 24 hours for bacterial culture and 25⁰-27⁰C for 5 days for fungal growth.

Sub-Culturing By Streak Method

Nutrient agar, potato dextrose agar was prepared poured into plates aseptically and allowed to solidify respectively. Distinct colonies on the samples obtained were sub-cultured using an inoculating loop by streaking on the sterile plate. These were incubated at 37⁰C for 24 hour for bacteria culture and 27⁰C for 5 days for fungi culture. Subsequent sub-culturing was carried out until pure cultures of different isolates were obtained. This pure isolates were transferred into agar slants in McCartney bottles and kept in the refrigerator at 4⁰C to serve as stock culture for subsequent tests during identification of organism (Olutiola and Famurewa, 1991)

Laboratory identification of fungi

Yeast identification

Different colonial types were purified by transferring into sterile potato dextrose plate. Each pure colonial isolates was inoculated into a sterile potato dextrose agar slants and stored in refrigerator.

Colonial Morphology

The vegetative cells of the pure culture of the yeast isolates were streaked on sterile potato dextrose agar plate. The plates were incubated at 30⁰C for 48 hours. The shapes, color, edge and the growth elevation were examined.

Cellular Morphology

Smears of the pure cultures of the yeast isolates were prepared and stained with lactophenol-in-cotton blue and allowed to act for 30seconds and then washed off with distilled water. The slides were blot dried in between fold of filter paper and observed at oil immersion objective and x40 objective.

Biochemical Test and Identification of Bacterial Isolates

Standard microbiological methods were used to identify the microorganisms obtained. The bacteria isolates were identified making use of 24hours old cultures that were Gram Stained for cell morphological differentiation. Among the test carried out include, catalase test, carbohydrate fermentation test for sugars such as glucose, fructose, lactose, galactose, arabinose, maltose and sucrose according to modified methods of was used. 1% of each carbohydrate was prepared into test tubes in triplicates containing Durham tubes in an inverted position. Two (2) drops of phenol red indicator was added in a peptone medium.

These were then autoclaved at 112°C for 10minutes. Sugar test tubes were inoculated with appropriate isolate while control tubes were prepared without inoculation. The tubes were incubated and observed daily for two to ten days for ability to utilize the a particular sugar as carbon source of energy leading to acid production signified by change in colour of the medium from red to yellow. This may be accompanied with gas production on the top of the inverted Durham tubes provided. The Bacterial isolates were also examined for Endospore Staining, Motility test and Starch Hydrolysis (Cowan and Steel, 1985; Choa *et. al*, 2004; Forbes *et. al.*, 2007).

Results

The study shows that various types of microorganisms were encountered in tomatoes and canned tomato product analyzed in the laboratory. The organisms that were isolated include eight bacteria species and three fungi species. Different reasons can be adduced from the presence of these organisms. It may be due to under processing, inadequate cooling, contamination of the can resulting from leakage through seams and finally, the pre-process spoilage. Since some canned foods received low heat treatment, it is to be expected that a rather large number of different types of microorganism may be found on examining such foods.

The range of the microbial load in the tomato sample is taken from the dilution factors of 10^3 and 10^5 for the bacteria culture and the colony forming unit ranges from $18-42 \times 10^3$ Cfu/ml and $1-15 \times 10^5$ Cfu/ml. Table 1 shows the microbial load of samples studied. This range from 1×10^5 in CT1 to 38×10^5 in CT3. In table 2, the bacteria isolates encountered were characterized for identification purposes into ten different species categorized into eight genera. Similarly, table 3 shows microbiological characterization of fungi isolates. Three different species of fungi were mainly identified during the study. Changes in the physical and organoleptic properties of canned tomatoes were also determined in this study (Table 4). In general, table 5 shows the various types of bacteria and fungi isolates encountered during the study.

Table 1: Microbial Load of Sample on Nutrient Agar

SAMPLES	MICROBIAL LOAD (Cfu/ml $\times 10^5$)
CT1	15
CT2	38
CT3	1
RT4	10
RT5	21

Legend: Canned tomatoes, CT1 –CT3; Raw tomatoes, RT1 –RT2

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306 TABLE 2: Biochemical Characteristics of Bacterial Isolates

LAB CODE	CULTURAL CHARACTERISTICS OF ISOLATES	GRAM RXN	MOTILITY	CATALASE	STARCH HYDROLYSIS	ORNITHINE DECARBOXYLASE	SPORE	GLUCOSE	LACTOSE	SUCROSE	FRUCTOSE	GALACTOSE	ARABINOSE	MALTOSE	PROBABLE IDENTITY OF ISOLATES
TA1	RAISED, SMOOTH, SPHERICAL, ENTIRE CREAMY, TRANSLUCENT	+	+	-	-	+	-	+	+	+	+	+	+	+	<i>Staphylococcus</i> Species
TA2	RAISED SMOOTH SPHERICAL ENTIRE YELLOWISH TRANSLUCENT	+	+	+	-	-	-	+	+	+	+	+		+	<i>Planococcus</i> Species
TA3	FLAT SMOOTH SPHERICAL ENTIRE CREAMY OPAQUE	+	-	+	+	-	-	+	+	+	-	+	-	-	<i>Micrococcus</i> Species
TA4	FLAT SMOOTH LONG RODS RHIZOID CREAMY OPAQUE	+	+	+	+	+	+	-	+	-	+	+	-	+	<i>Bacillus</i> Species
TA5	FLAT ROUGH SHORT RODS ENTIRE YELLOWISH OPAQUE	+	+	-	+/-	+	-	+	+	+	+	+	+	+	<i>Streptococcus</i> Species
TA6	RAISED SMOOTH SPHERICAL ENTIRE CREAMY OPAQUE	+	-	-	-	-	-	+	+	+	+	+	+	+	<i>Leuconostoc</i> Species
TA7	RAISED SMOOTH	+	+	-	-	-	-	+	-	+	+	+	-	-	<i>Pediococcus</i> Species

	SPHERICAL ENTIRE GREYISH WHITE OPAQUE														
TA8	FLAT SMOOTH SHORT RODS ENTIRE WHITISH TRANSLUCENT	+	-	+	+	+	-	+	+	+	-	+/-	-	+	<i>Micrococcus Species</i>
TA9	RAISED ROUGH LONG RODS RHIZOID CREAMY OPAQUE RAISED ROUGH LONG RODS RHIZOID CREAMY OPAQUE	+	+	+	+	+	+	+	+	+	+	-	-	-	<i>Bacillus Species</i>
TA10	FLAT ROUGH SPHERICAL RHIZOID CREAMY OPAQUE	+	+/-	-	+	+	+	+	-	+	+	+	-	+	<i>Clostridium Species</i>

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317 TABLE 3: Microbiological Characterization of Fungi Isolates

CODE OF ISOLATES	COLONY MORPHOLOGY	CELL SHARE	ASCOSPORE	PSEUDOMYCELLUM	PROBABLE IDENTITY OF ISOLATES
TF 1	Cream colored, smooth edge surface and rinsed	Oval	+ve	-ve	<i>Saccharanuyces species</i>
TF 2	Cream colored, smooth edge surface and rinsed	Ellipsoidal	+ve	-ve	<i>Saccharanuyces species</i>
	white mold to grey in color to black color underneath plate	Mold	-ve	+ve	<i>Aspergillus species</i>
TF 4	white to orange coloration mold	Mold	-ve	+ve	<i>Neurospora species</i>

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320 TABLE 4: Morphological Changes in the Physical and Organoleptic Properties of Canned
321 Tomatoes

STORAGE DAYS	COLOR	TASTE	FLAVOUR/ODOUR	GAS PRODUCTION
1 st Week	Reddish brown	Slightly salty	Good and acceptable	Nil
2 nd week	Light brown	Slightly salty	Good and acceptable	Nil
3 rd week	Light brown	Slightly salty	Slightly sour-like odor	Nil
4 th week	Brownish black	Slightly salty	sour-like odor	slight Bubble formation
5 th week	Black	Unpleasant taste	Off flavor	Bubble formation

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326 TABLE 5: Types l and Fungal species obtained

BACTERIAL SPP. ISOLATED	FUNGAL SPP. ISOLATED
<i>Staphylococcus species</i>	<i>Saccharomyces species</i>
<i>Planococcus species</i>	<i>Aspergillus species</i>
<i>Micrococcus Species</i>	<i>Neurospora species</i>
<i>Bacillus Species</i>	
<i>Streptococcus Species</i>	
<i>Leuconostoc Species</i>	
<i>Pediococcus species</i>	
<i>Clostridium species</i>	

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329 Discussion and Conclusion

330 The microbiological study of raw tomatoes and canned tomato products which was
 331 analyzed in the laboratory showed that various microorganisms could be isolated from both the
 332 raw and the canned tomatoes. Observations signify the presence of certain active sugar
 333 fermenters such as the lactic acid bacteria which ferments lactose sugar and the microorganisms
 334 which are present as natural microflora of tomatoes. They include organisms such as
 335 *Leuconostoc saccharomyces* as shown in the work of Schlegel (2002) and Mabbitt and Mossel,
 336 (1967).

337 Spoilage microorganism was also isolated after some weeks of opening of the tomato
 338 can. This study shows some spoilage microorganisms associated with the product such as
 339 *Bacillus spp.* and *Clostridium spp.* This is consistent with the study of Herson and Hullard, (1989)
 340 which demonstrated the involvement of this group of organisms in spoilage. Based on some

routine laboratory measures as prescribed by Cheesebrough, (2004), the bacterial load observed during the study ranged from 42×10^3 cfu/ml to 86×10^3 cfu/ml after long preservation. Similarly, the least count immediately after opening of can range from low of 2×10^3 cfu/ml to 15×10^3 cfu/ml. This is consistent with some range of microbial population of some processed food stuff demonstrated in previous study. The highest growth was obtained after opening of can and exposure of tomatoes to air due to presence of contaminants and spoilage microorganism which shows mold formation on the surface of tomatoes and the change in color from reddish brown to brownish black.

In conclusion spoilage microorganisms isolated from raw (local) tomatoes are significantly much more than those isolated from the canned tomatoes thus giving an assurance of canning as a good means of preserving foods such as tomatoes through adequate heat treatment for a long period of time as stipulated by the shelf life. Also the technology of canning needs to be improved by taking adequate precautions to ensure safety during the process.

REFERENCES

- Adams E. (1998). Studies on putrefactive anaerobes as spoilage agents in canned foods.
- American Public Health Associated (APHA) (1998). Standard method for examination of water and waste water, 20th Ed. American Public Health Associated Inc, New York. American Water Work Associated (AWWA). Research Foundation, 1993. Bacterial examination of water. West Quincy Avenue Denver, pp. 81-85.
- Andres E. K. (2006) sorting out tomato canning directions national centre for food preservation

367 Ayres W.L (1980). Studies on the microbial spoilage of canned foods. Isolation and
 368 identification of some spoilage bacteria.

369 Bucchan G.J (2008) Basic Food Microbiology; AVI publishing company, Westport

370 Cheesebrought M. (1984) Standard for canned tomatoes. Codex alimentarius

371 Cheesbrought, M. (2004), District Laboratory Practice in Tropical Countries. Part 2, 3rd ed pp:
 372 178-88 Cambridge University press, U.K.

373 Choa, K.K. Choa C.C. and Choa, W.L. (2004). Evaluation of Colilert 18 for detection of
 374 coliforms, and Escherichia coli subtropical freshwater, Applied Environ Microbiol,
 375 70:1242-1244

376 Cowan, S.,T and Steel K.J (1985), Mannual for the Identificatin of Bacteri, Cambridge
 377 University Press, Verlage, New York

378 Fields M.L (1970). The flat four bacteria

379 Forbes, B.A Sahum, D.F Weissfeld, A.S (2007), Bailey and Scot's Diagnostic Mircobiology 12th
 380 ed. MosbyElsevier Pub.

381 Gerad C.W (1598). Canning a major process in the preservation of foods

382 Herson AC and Hullard E.D (1989). Canned foods, an introduction to their microbiology

383 Jay J.M (1976) Modern food Microbiology.

384 Mabbitt D.A and Mossel A. (1967) General principle of controlling microorganisms, transmission
 385 of disease by food and other aspects of food microbiology. In "Microbiology of Foods".
 386 The University of Utrecht, The Netherlands publication.

387 Nicholas C.W (1809) All about canned foods, Prentice hall Englewood cliffs. A popular
 388 treatment of food item that has become a natural favorite in the last two decades.

389 Njoku O.F (1991). Food Microbiology, McGrawHill Book Company.

- 390 Olutiola P.O and Famurewa O. (1991). General Laboratory Technique in the Assaying of
391 Microorganism
- 392 Prescott M.L Harley P.J and Klein A.D.(2008). Microbiology. (7th Edition) Wm C. Brown
393 publishers. New York, U.S.A.
- 394 Redlinger P (2001). Canning and freezing tomatoes
- 395 Salmon (1987) Basic Food Microbiology
- 396 Schlegel HG (2002). General Microbiology. 7th Edition Cambridge University Press. P 480.
- 397 Schmitt, H.P (1996) Commercial sterility in canned foods, its meaning and determination
398