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Research Article

MICROBIAL SPOILAGE OF CANNED TOMATO SOLD IN BENIN CITY

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ABSTRACT

Tomato (*solanum lycopersicum*), is one of the most important vegetable crop of the solanaceae family, grown all over the world for food and other economic purposes. The microbial spoilage of canned tomato of varying product brands was investigated in this study. It was observed that the total aerobic and anaerobic counts were less than 10^3 cells which were within acceptable limit. Two of the canned product had no microbial count, while the others had counts varying from 2×10^1 to 5×10^1 for aerobic count of freshly opened tomato, and 1×10^1 to 2×10^1 for anaerobic count. However, aerobic count of spoilt canned tomato product ranged from 4.2×10^4 to 9.1×10^4 across all six products investigated. Anaerobic count of spoilt canned tomato ranged from 2.5×10^4 to 6.8×10^4. Isolated organisms obtained from spoilt canned tomato samples revealed the presence of *Bacillus ploymyxa, Staphylococcus aureus, Streptococcus lactis, Pseudomonas,* sp., *Clostridium sporogenes, Bacillus coagulans, Saccharomyces* sp., *Candida* sp., *Mucor* sp., *Aspergillus niger,* and *Penicillium* sp. These organisms were implicated in the spoilage of canned tomato products sold in Benin City. When these products are consumed immediately after opening, they are safe because the microbial load on fresh product is within acceptable regulatory standard.

Keywords: Canned tomatoes, Regulatory standard, Aerobic count, Anaerobic count

1. INTRODUCTION

The common garden tomato (*Lycopersicon esculentum*) is botanically classified as a fruit, although, some persons think of it as a vegetable [1]. The United States Department of Agriculture [2] for example, defined it as a vegetable. Tomato is widely used as condiment or as food dietary supplement in various part of the world and also valuable in the food industry [3].

Canene-Adams *et al*. [4] reported that tomatoes are the fourth most commonly consumed fresh vegetable and the most frequently consumed canned vegetable in the American diet and showed the connection between increased tomato consumption and reduced risk for both cardiovascular disease and prostate cancer thus makes it valuable food source all over the world. In areas and situations where, in season, perfectly ripe tomatoes are not available, canned tomatoes are of alternative to prepare dishes such as sauce or pizza. The top uses of canned tomato are in Italian, chill, soup, pizza, stew, casseroles and Mexican dishes [3]. Canning is the process of placing food in containers or jars and heating the jars to a temperature that destroys microorganisms that could be a health hazard or cause the food to spoil [5]. This heating process also destroys enzymes that may cause undesirable changes in the flavor, colour and texture of the food. Canning is an important and safe method of food preservation if practiced properly. Canning is intended to destroy harmful microbes in food, however, with improper handling, cans become breeding grounds for microbes.

Canning destroys the microbial contaminants, however, products undergo microbial spoilage and could cause food borne illness as a result of under processing, inadequate cooling contamination of the can resulting from leakage and preprocess spoilage [6]. Canned foods have been reported to be contaminated mainly by spore forming bacteria of the genera *Bacillus, Clostridium* and *Desulfotomaculum* [7]. If the contaminant is a pathogen and the food is capable of supporting its growth, a health hazard exists [8]. *Bacillus coagulans* and *Bacillus stearothermophilus* have been implicated in canned tomato juice and milk causing flat sour spoilage with acid but no gas production from carbohydrate [9, 10].

Kendal [11] reported that canned foods provide a moist, yet oxygen-free environment that favors the growth of certain microorganisms. While most microorganisms are destroyed in the heating process, the organism that can survive in a moist, oxygen-free environment and which is of most concern in home canning is *Clostridium botulinum*. This organism causes the often fatal disease known as botulism. *Clostridium botulinum* is able to grow without oxygen (air) and thrives where there is little acid available. This particular microorganism exists as a bacterial vegetative cell under favorable growth conditions, but reverts to a spore stage under unfavorable conditions. The spores are very heat-resistant, yet can be destroyed during the canning process.

Industrially, 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.

Temperature higher than 100°C 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 than the boiling point of water (100°C), a pressure canner can be used. The temperature of at least 115.6°C is needed for the destruction of *Clostridium botulinum* spores [3]. Therefore canning of low acid food is done in the pressure canner at 10 or 11 pounds of pressure (115.6°C) or at 15 pounds of pressure (121°C). Compositionally, the tomato has a unique nutritional and (phyto) chemical profile. Vitamin C, vitamin A (as carotenoids), fiber, potassium, and the antioxidant lycopene are natural components of tomatoes. Lycopene is the major dietary carotenoid and tomatoes and tomato based foods are the richest sources of lycopene in the American diet [12]. Besides tomatoes, lycopene is also found in watermelon and red grapefruit; however, tomatoes and tomato products represent more than 85% of all the dietary sources of lycopene consumed in the North American diet. Average daily lycopene intake of males and females is 5305 mg, higher than the average daily intake of all other carotenoids combined (3388 mg). Lycopene intake is about 3 times that of b-carotene (1742 mg) [13]. This study was carried out to determine the microorganisms associated with spoilage of opened canned tomato as well as determine the microbial load of ready to eat canned tomatoes.

2. MATERIALS AND METHODS

2.1. Sample Collection

Six different brands of canned tomatoes were purchased from the market. The canned tomatoes products were Day by Day, De-Rica, Gino, Fuamnella, Addlin and Clappa. The samples were brought to the laboratory and analyzed immediately.

However, aforementioned products of canned tomato purchased were punctured/opened and allowed to stand for a few days in-order to develop certain signs of spoilage which includes off-odour and off colour.

2.2. Microbiological Analysis of Tomato Samples

Each sample was serially diluted using sterile distilled water as diluent and Iml of the appropriate dilution was plated in duplicate using the pour plate method on nutrient and potato dextrose agar. The nutrient agar plates were incubated at 37^0C for the 24 hours. The potato dextrose agar plates were incubated at room temperature (28^0C) for 72 hours. The colonies that developed on the nutrient agar plates were counted and used to determine the total bacterial count of the canned tomato samples (cfu/ml). Representative colonies on the plates were sub-cultured on fresh nutrient agar to obtain pure cultures of the isolates. The pure cultures were then transferred onto nutrient agar slants for biochemical identification.

2.3. Anaerobic bacteria counts

Pour plate method was employed for the determination of anaerobic bacteria counts of samples nutrient agar. The inoculated nutrient agar plates were incubated in an anaerobic gas jar containing a lit candle to create anaerobic condition.

3. RESULTS

The mean total aerobic and anaerobic bacteria counts for the canned tomatoes are shown in Table 1. It revealed that Day by Day, Derica, Fuamnella had higher microbial loads compared to Gino and Addlin. The aerobic and anaerobic counts of the canned tomato ranged from 4.2×10^4 -9.5×10^4 and 2.5×10^4 -6.8×10^4 cfu/g respectively. The aerobic and anaerobic counts of the canned tomato before spoilage ranged from 2.0×10^1 - 5.0×10^1 and 1.0×10^1 -2.0×10^1 cfu/g respectively. The total fungal counts ranged from 5.0×10^3 - 3.1×10^4 cfu/g. All six spoilt canned tomato showed strong gas formation and had a pungent odor. The microorganisms isolated from the spoilt canned tomato were *Bacillus polymyxa, Staphylococcus aureus, Streptococcus lactis, Pseudomonas* sp., *Clostridium sporogenes, Bacillus coagulans. Saccharomyces* sp., *Candida* sp., *Mucor* sp., *Penicillium* sp. and *Aspergillus niger*, *Bacillus coagulans* and *Staphylococcus aureus* were the predominant microorganisms isolated.

Table 1: Total aerobic and anaerobic bacteria counts of spoilt canned tomatoes

Canned tomato sample	Counts (cfu/g) x 10^4	
	Aerobic	Anaerobic
A	9.1	4.7
B	4.2	4.0
C	5.2	3.0
D	6.0	5.1
E	9.5	2.5
F	7.3	6.8

***Note** : A = Day by Day brand; B = Gino brand; C = Addlin brand; D = Clappa brand; E = Derica brand; F = Fuamnetta brand*

Table 2: Total aerobic and anaerobic bacteria counts of unspoilt canned tomatoes

Canned Tomato Sample	Counts (cfu/g) x 10^1	
	Aerobic	Anaerobic
A	5.0	2.0
B	Nil	Nil
C	Nil	Nil
D	2.0	1.0
E	3.0	2.0
F	3.0	1.0

***Note** : A = Day by Day brand; B = Gino brand; C = Addlin brand; D = Clappa brand; E = Derica brand; F = Fuamnetta brand*

Table 3: Total fungal counts of unspoilt canned tomatoes

Canned tomato sample	Fungal counts (cfu/g) x 10^1
A	Nil
B	2
C	1
D	2
E	2
F	1

***Note** : A = Day by Day brand; B = Gino brand; C = Addlin brand; D = Clappa brand; E = Derica brand; F = Fuamnetta brand*

Table 4: Total fungal counts of spoilt canned tomatoes

Canned tomato sample	Fungal counts (cfu/g)
A	6.0×10^3
B	1.1×10^4
C	3.1×10^4
D	5.0×10^3
E	1.4×10^4
F	1.5×10^4

***Note** : A = Day by Day brand; B = Gino brand; C = Addlin brand; D = Clappa brand; E = Derica brand; F = Fuamnetta brand*

4. DISCUSSION

The absence of blown and leaky cans could suggest that all the canned tomatoes analyzed before spoilage within expiry date from manufacture is of acceptable quality for consumption. The fresh canned tomato analyzed had low microbial loads less than 10^3 within acceptable microbiological quality [14]. The above fact was evident with figures obtained from table 2. The combined effects of high temperature treatment, pH, preservatives and anaerobic condition of canning could have been responsible for the low microbial loads of the fresh canned tomatoes. The high microbial counts of some of the samples analyzed (as seen from aerobic bacterial count of Day by Day canned tomato in table 2) could be a reflection of the quality of the raw materials, under processing, pre-process contamination and to the level of stringency in their production. The aerobic and anaerobic counts of the spoilt canned tomato ranged from 4.2×10^4 - 9.5×10^4 and 2.5×10^4 -6.8×10^4 cfu/g respectively. The aerobic and anaerobic counts of the canned tomato before spoilage range from 2.0×10^1 - 5.0×10^1 and 1.0×10^1 -2.0×10^1 cfu/g respectively. The total fungal counts ranged from 5.0×10^3 -3.1×10^4 cfu/g. The microorganisms isolated from the spoilt canned tomato were *Bacillus polymyxa, Staphylococcus aureus, Streptococcus lactis, Pseudomonas* sp., *Clostridium pasterianum, Bacillus coagulans. Saccharomyces* sp., *Candida* sp., *Mucor* sp., *Penicillium* sp. and *Aspergillus niger*. The isolation of *Bacillus coagulans, Bacillus polymyxa* and *Clostridium sporogenes* could be explained by the fact that they are spore formers and known common environmental contaminants, they have been implicated in canned foods [7, 10, 15]. *Clostridium* and *Bacillus* species are pathogens that can cause infection and food poisoning, they are known to have extreme wide growth temperature of 20-50°C [10, 15, 16]. The presence of *Bacillus* and *Clostridium* in canned food, even though in very small amount, calls for concern as temperature abuse and poor storage conditions prevalent in kiosks and stores from where these products were purchased, could encourage proliferation of these organisms to unacceptable level.

Bacillus coagulans and *Clostriduim sporogenes* have been reported as spoilage organisms in Tomatoes, causing flat sour spoilage, putrefaction, rancidity and off-flavour [9, 17], their presence in canned food portend possible spoilage if storage conditions become favourable due to abuse.

Staphylococcus aureus and *Pseudomonas* are of human flora, they are known opportunistic pathogens. Contamination of canned foods could be via food producers/handlers and equipments. They are facultative and hardy organisms, thus their survival in canned foods could be explained. Toxigenic strains of *Staphylococcus aureus* have been implicated in foodborne illness and are known to proliferate in conditions of temperature abuse [18-21]. That the pre-enriched samples yielded more organisms than the direct culture could be explained by the fact that shelf stable canned foods packed in hermetically sealed containers are not absolutely sterile and thus contain injured and suppressed micro-organisms that could proliferate if storage conditions and integrity of the container is compromised. Regular surveillance and checks to monitor canned foods on sales is therefore necessary for effective food safety.

5. CONCLUSION/RECOMMENDATIONS

The results of this present study showed that the spoilt canned tomatoes produced microbial growth including bacteria and fungi. Therefore further studies are necessary to provide information concerning spoilage of canned tomatoes by revealing the nature of contamination. The use of substances with effective antimicrobial effects against spoilage microorganisms is necessary during production of canned food.

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