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Microbial Assessment of Spoilt Tomatoes (*Solanum lycopersicum* Linn) Being Sold in Some Markets in Ondo City, Nigeria

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Abstract
Tomatoes (Solanum lycopersicum Linn) are one of the most consumed fruits in Nigeria and the world at large but they are highly susceptible to microbial spoilage. Consumption of these spoilt tomatoes could increase the risk of food poisoning and also cause serious health issues which are of public health concern. This study was therefore designed to investigate the bacteria and fungi associated with spoilt tomatoes being sold in some selected markets in Ondo city. Different media (Nutrient, MacConkey, Mannitol Salt, Salmonella –Shigella, Eosin Methylene Blue, Sorbitol MacConkey and Potato Dextrose agar) were used for the determination of the total viable bacterial and fungal counts from the samples collected from Odoshida, Adeyemi and Iyalaje markets in Ondo using the pour plate technique. The isolates obtained after subculturing were characterized based on their cultural, morphological and biochemical characteristics. The total bacterial count ranged from 1.25 $\times 10^8$ to 8.06 $\times 10^8$ cfu/mL while the total fungal count ranged from 2.75 $\times 10^5$ to 5.65 $\times 10^6$ cfu/mL. The identified bacteria obtained were Staphylococcus species, Proteus species, Salmonella species, Pseudomonas species, Escherichia coli, Klebsiella species, Shigella species, Enterobacter species and Bacillus species, while the fungi were Alternaria species, Penicillium species, Aspergillus species, and Rhizopus species. All the isolates obtained from the selected samples are of public health concerns because of their pathogenic and toxigenic nature; an indication that spoilt tomatoes ordinarily should not be consumed or consumed with utmost caution.
Keywords: Solanum lycopersicum, spoilt tomatoes, microbial spoilage, food poisoning, public health concerns

INTRODUCTION
Fruits and vegetables have been known as sources of essential nutrients to human beings because they provide humans with vitamins, fats, minerals, and oil needed for body growth as well as development. *Solanum lycopersicum* Linn is one of the most consumed fruits among Nigerians and throughout the world. However, they are highly susceptible to microbial spoilage due to their physicochemical compositions such as pH, moisture content and water content which are necessary for microbial growth (Bai and Lindhout, 2006; Singh *et al.,* 2007).

The invasion of tomato fruits by microorganisms makes them undesirable for human consumption. Also, fungal spoilage of tomatoes constitutes a potential health hazard to humans including animals due to their production of secondary toxigenic metabolites such as aflatoxin and ochratoxin, following ingestion or inhalation (Mbajiuka and Enya, 2014). In Nigeria, spoilt tomatoes are cheaper and come in larger quantities compared to fresh and whole tomatoes making them more appealing to the larger population for consumption especially due to economic hardship. The consumption of spoilt tomatoes could increase the risk of food poisoning and also cause serious health issues such as cancer of the liver. This study was therefore designed to investigate the bacteria and fungi that are present in spoilt tomatoes and also study their antibiotic sensitivity pattern.

MATERIALS AND METHODS

Study area
Three markets; Odoshida, Iyalaje and Adeyemi students' market located in Ondo Town, Ondo State, Nigeria were used.

Collection of samples
Two methods were employed to obtain the samples from the selected markets. One, spoilt tomatoes were purchased and two, fresh, undamaged tomato fruits were bought and allowed to undergo natural spoilage. These were placed separately in sterile polyethylene bags and transported to the laboratory for analysis (Obunukwu *et al*., 2018).

Preparation of media

General purpose media; Nutrient agar and Potato dextrose agar as well as differential and selective media, Macconkey agar, Mannitol Salt agar, Salmonella-Shigella Agar, Eosin Methylene Blue agar, Sorbitol Macconkey agar used were prepared following standard microbiological procedure and in accordance to instructions from the manufacturers (Onyemata and Ibrahim, 2018)

Processing of the spoilt tomatoes and enumeration of microbial load

Mortar and pestle sterilized at 121^{o}C for 15 minutes were used to grind the spoilt tomatoes to make a homogenate. An eight-fold serial dilution of the homogenate was made in sterile test tubes. One millimeter (1 ml) of the eight-fold dilution was aseptically transferred and plated in duplicates using the selected media previously listed in duplicates. However, 1 ml of the sixth dilution was employed for the enumeration of fungi from the sample using the pour-plate technique. The plates incubated at 37^{o}C for 24-48 hours and 25^{o}C for 5-7 days for bacteria and fungi respectively. The colonies were subultured until pure cultures were obtained and were stored at 4°C for further analysis (Obunukwu *et al*., 2018).

Characterization and identification of isolates from tomato fruits

The bacterial isolates obtained from the tomato fruits were identified based on their cultural, morphological, microscopic examination and biochemical characteristics. Gram staining reaction test was used for the morphological and microscopic examination. The biochemical tests conducted include catalase, methyl red, Voges-proskauer, citrate utilization, lactose fermentation and indole tests (Cheesebrough 2005; Obunukwu *et al*., 2018; Prescott *et al*., 2018). Fungal isolates were identified using microscopic and macroscopic characteristics.

Antibiotics susceptibility testing of the bacterial isolates.

Each bacterial isolate was inoculated into sterile nutrient broth in test tubes and left at room temperature for 24 hours. The broth was observed for growth by checking its turbidity and comparing it to the Macfarland standard. Thereafter, each isolate was swabbed on sterile Mueller Hilton agar plates in duplicates. Antibiotic discs for Gram-positive and for Gram-negative bacteria were placed on the inoculated poured plates with the aid of a sterile pair of forceps, and incubated at 37^{o}C for 18-24 hours. The zones of inhibition were measured in millimetres with a metre rule, and recorded (Mohammed and Kuhiyep, 2020).

Statistical analysis

The data obtained was statistically analyzed by using MS Excel Programme of MS Office 2007 (Ghulam *et al*., 2020).

RESULTS AND DISCUSSION

The results of total viable microbial count showed the count was between 3.13×10^{8} and 7.61×10^{9} cfu/mL as well as from 2.4×10^{5} to 4.75×10^{6}cfu/mL for bacteria and fungi respectively (Table 1). The identities of the bacterial isolates from the tomato samples based on the morphological and biochemical properties are as shown in Tables 2, 3 and 4. A total of nine bacterial isolates were obtained; *Staphylococcus* species, *Proteus* species, *Salmonella* species, *Pseudomonas* species, *Escherichia coli, Klebsiella* species, *Shigella* species, *Enterobacter* species and *Bacillus* species. The highest number of isolates was obtained from Odoshida and Adeyemi markets. Also, the identities of the fungal isolates from spoilt tomatoes are shown in Tables 5, 6 and 7 with the Odoshida market having the highest number of fungal isolates. Four different genera of fungi were obtained; *Alternaria*, *Aspergillus*, *Penicillium*, and *Rhizopus*. The percentage occurrence of both the fungal and bacterial organisms isolated is as shown in Tables 8 and 9. Among the isolated bacterial species, *Staphylococcus* spp had the highest occurrence while the least were *Proteus* spp., *Pseudomonas* spp and *Salmonella*.

Poor personal hygiene of tomato sellers could be responsible for the presence of *Staphylococcus* species and this could lead to food poisoning. In previous studies, this organism was also isolated from spoilt tomatoes (Ogundipe *et al*., 2012; Wogu and Ofuase, 2014; Bello *et al*., 2016; Chandu *et al*., 2016; Mohammed and Kuhiyep, 2020; Momoh, *et al*., 2020). *Bacillus subtilis* was found in studies by Chandu *et al*. (2016) and Momoh *et al*. (2020). *Bacillus cereus* and *B. aureus* were observed in studies by Wogu and Ofuase (2014) and Chandu *et al*. (2016) while *B. brevis, B. polymyxa* and *B. megaterium* was observed in studies by Agbabiaka *et al*. (2015).The presence of *E. coli* in this study indicated faecal contamination which may be as a result of the type of fertilizer used (organic manure) during cultivation, water and the handlers. The occurrence of this organism was at 20%. The organism was also found in the studies by Ogundipe *et al*. (2012), Obunukwu *et al*. (2018), Mohammed and Kuhiyep (2020) and Momoh *et al*. (2020). *Enterobacter* species was also observed in this study, and it tallied with the study carried out by Ogundipe *et al*. (2012). *Proteus* species was also found in this study, and this is in agreement with studies carried out by Ogundipe *et al*. (2012) who found *Proteus mirabilis*, which had an occurrence of

2.5%, and Wogu and Ofuase (2014) who also found *Proteus mirabilis* which occurred at 1.6% prevalence. Agbabiaka *et al.* (2015) and Momoh *et al. (*2020) also found *Proteus mirabilis* in their studies. The presence of *Salmonella* species might be attributed to poor cultivation practices and poor hygiene of the farmers and handlers. The ingestion of tomatoes infected with *Salmonella* species, can cause *Salmonella* food poisoning known as salmonellosis. *Klebsiella* species, was also found in this study as this was found in a study by Obunukwu *et al*. (2018) while, *Klebsiella aerogenes* was observed in studies by Wogu and Ofuase (2014) and Chandu *et al.* (2016). *Pseudomonas* species was also observed. It was also found in studies by Mbajiuka and Enya (2014), Agbabiaka *et al.* (2015) and Obunukwu *et al*. (2018). *Pseudomonas fluorescens* was observed in the study of Agbabiaka *et al*. (2015) while *Pseudomonas aeroginosa* was observed in studies by Wogu and Ofuase (2014), Chandu *et al.* (2016) and Momoh *et al*. (2020).

Penicillium species were also observed in this study. This organism produces ochratoxin, which is very dangerous and causes serious health problems when consumed. This was also observed in studies by Wogu and Ofuase (2014), Chandu *et al*. (2016), Dimphna (2016) and Mohammed and Kuhiyep (2020). *Penicillium notatum* and *Penicilium expansium* were observed in the study by Mbajiuka and Enya (2014), *Penicillium oxalicum*, in the study by Momoh *et al* (2020), and *Penicillium digitatum* was observed in the study by Onuorah and Orji (2015). *Aspergillus* species was also observed in this study. *Aspergillus* species are capable of producing aflatoxin, which is mostly heat-resistant, and causes cancer when ingested. This was also observed in a study by Obunukwu *et al*. (2018). *Aspergillus flavus* was observed in the studies by Mbajiuka and Enya (2014), Bello *et al*. (2016), Mohammed and Kuhiyep (2020) and Momoh *et al* (2020). *A. fumigatus* was observed in a study by Mbajiuka and Enya (2014). *A. niger* was observed in the studies by Mbajiuka and Enya (2014), Onuorah and Orji (2015), Chandu *et al*. (2016), Onyemata and Ibrahim (2018), Ghulam *et al.* (2020) and Momoh *et al* (2020)). *Alternaria* species was observed in this study at the highest prevalence percent of 44.4%. It was also seen in a study by Agbabiaka *et al*. (2015). While *Alternaria alternata* was observed in studies carried out by Onuorah and Orji (2015) and Ghulam *et al.* (2020). *Alternaria solani* was observed in a study by Ghulam *et al.* (2020). *Rhizopus* species were also found in this study at 22.2% occurrence. This fungal genus was also found in the studies by Chandu *et al*. (2016), Dimphna (2016) and Obunukwu *et al*. (2018). *Rhizopus stolonifer* was observed in studies by Agbabiaka *et al.* (2015), Bello *et al*. (2016), Momoh *et al.* (2020) and Ghulam *et al*. (2020). *Rhizopus oligosporus* was found in a study by Momoh *et al.* (2020).

Antibiotic susceptibility patterns of the bacterial isolates

The susceptibility patterns of the bacterial isolates are presented in Tables 10, 11, 12, 13, 14 and 15. The results showed that most of the isolates showed resistance to the antibiotics. Generally, the Gram-negative bacterial isolates were all resistant to Ampicillin, Nalidixic acid and Ceporex while the Gram-positive bacteria were resistant to Ciproflox, Norfloxacin, Amoxil and Ampiclox. This study does not conform to the study by Wogu & Ofuase (2014) as *Pseudomonas* species and *Salmonella* species were not susceptible to all the antibiotics.

Table 1. Microbial load in spoilt tomatoes

No. of samples	**Fungal count** ($\times 10^6$ **cfu/mL**)	**Bacterial count** ($\times 10^8$ **cfu/mL**)
1	5.27	2.95
2	4.33	5.12
3	4.75	3.58
4	2.75	3.04
5	2.69	7.61
6	1.25	3.55
7	5.65	2.89
8	2.71	1.18
9	2.4	3.13
10	2.25	3.76

Key: *PDA- Potato dextrose agar; NA- Nutrient agar*

Table 2. Cultural, morphological and biochemical characteristics of bacterial isolates in spoilt tomatoes from Odoshida market

Isolate	Cultural Characteristics	Gram Staining	Shape	Cat.	Cit.	Ind.	M.R.	V.P.	Lac	Coa	Probable Organisms
I_1	Yellow, transparent colony on NA.	+ ve	Cocci	+ ve	+ ve	- ve	+ ve	+ ve	+ ve	+ ve	*Staphylococcus aureus*
I_5	Entire, white, elevated colony on NA	+ ve	Rod	+ ve	+ ve	- ve	+ ve	+ ve	+ ve	-	*Bacillus* spp.
I_6	Small, white round colony on MSA	+ ve	Cocci	+ ve	+ ve	- ve	+ ve	+ ve	+ ve	+ ve	*Staphylococcus aureus*
I_9	Entire, red colony on MAC	- ve	Rod	+ ve	+ ve	- ve	- ve	+ ve	+ ve	-	*Enterobacter* spp.
I_{12}	Colourless, irregular, raised, opaque, colony on EMB	- ve	Rod	+ ve	+ ve	- ve	+ ve	- ve	- ve	-	*Proteus* spp.
I_{13}	Black, irregular colony on SSA	- ve	Rod	+ ve	- ve	- ve	+ ve	- ve	- ve	-	*Salmonella* spp.

Key: *Cat. - Catalase test; Cit. – Citrate utilization test; Ind. – Indole test; M.R. – Methyl red test; V.P. – Voges-proskauer test; Lac. - Lactose fermentation test; Coa. – Coagulase test*

Table 3. Cultural, Morphological and Biochemical Characteristics of Bacterial isolates in Spoilt Tomatoes from Adeyemi Student Market

Isolate	Cultural Characteristics	Gram Staining	Shape	Cat.	Cit.	Ind.	M.R.	V.P.	Lac	Coa	Probable Organisms
I_4	Small, yellow, rough, opaque colony on NA	+ ve	Rod	+ ve	+ ve	- ve	- ve	+ ve	+ ve	-	*Bacillus* spp.
I_{11}	Entire, purple, filamentous, moist, convex, viscid colony on EMB	- ve	Rod	- ve	+ ve	- ve	- ve	+ ve	+ ve	-	*Klebsiella* spp.
I_{14}	Colorless, transparent, round, flat, lobate colony on SSA	- ve	Rod	+ ve	- ve	- ve	+ ve	- ve	- ve	-	*Shigella* spp.
I_{15}	Round, smooth, medium, colorless colony on SSA	- ve	Rod	+ ve	- ve	- ve	+ ve	- ve	- ve	-	*Shigella* spp.
I_{16}	Red, raised, circular, butyrous colony on MAC	- ve	Rod	+ ve	- ve	- ve	+ ve	- ve	+ ve	-	*Escherichia coli*
I_{19}	Pink, butyrous, dentate, flat colony on SMAC	- ve	Rod	+ ve	- ve	- ve	+ ve	- ve	+ ve	-	*Escherichia coli*
I_{20}	Cream, raised, opaque, undulate colony on SMAC	- ve	Rod	+ ve	- ve	- ve	+ ve	- ve	+ ve	-	*Escherichia coli*

Key: *Cat. - Catalase test; Cit. – Citrate utilization test; Ind. – Indole test; M.R. – Methyl red test; V.P. – Voges-proskauer test; Lac. - Lactose fermentation test; Coa. – Coagulase test*

Table 4. Cultural, Morphological and Biochemical Characteristics of Bacterial Isolates in Spoilt Tomatoes from Iyalaje Market

Isolate	Cultural Characteristics	Gram Staining	Shape	Cat.	Cit.	Ind.	M.R.	V.P.	Lac.	Coa.	Probable Organisms
I_2	Small, yellow colony on NA	+ ve	Cocci	+ ve	+ ve	- ve	+ ve	+ ve	+ ve	+ ve	*Staphylococcus* spp.
I_3	Transparent colony on NA	+ ve	Cocci	+ ve	+ ve	- ve	+ ve	+ ve	+ ve	+ ve	*Staphylococcus* spp.
I_7	Yellow colony on MAC	- ve	Rod	+ ve	+ ve	- ve	- ve	- ve	- ve	- ve	*Pseudomonas* spp.
I_8	Pink, mucoid colony on MAC	- ve	Rod	- ve	+ ve	- ve	- ve	+ ve	+ ve	+ ve	*Klebsiella* spp.
I_{10}	Smooth, pink, round, raised, moist colony on EMB	- ve	Rod	+ ve	+ ve	- ve	- ve	+ ve	+ ve	+ ve	*Enterobacter* spp.
I_{18}	Cream, butyrous, transparent, raised, circular colony on SMAC	- ve	Rod	+ ve	- ve	- ve	+ ve	- ve	+ ve	-	*Escherichia coli*

Key: Cat. *Catalase test; Cit. – Citrate utilization test; Ind. – Indole test; M.R. – Methyl red test; V.P. – Voges-proskauer test; Lac. - Lactose fermentation test; Coa. – Coagulase test*

Table 5. Cultural and microscopic characteristics of fungal isolates of spoilt tomatoes from Odoshida market

Isolate	Texture	Type of hyphae	Colour	Shape	Conidiophore	Probable Organism
1	Powdery	Septate	Black	Round	Non-branched	*Aspergillus* spp.
2	Powdery	Septate	Creamy white	Round	Non-branched	*Aspergillus* spp.
3	Powdery	Septate	Greenish black	Round	Non-branched	*Aspergillus* spp.
4	Cottony	Non-septate	Grey	Filamentous	Branched	*Rhizopus* spp.
5	Powdery	Septate	Dark	Circular	Branched	*Alternaria* spp.

Table 6. Cultural and microscopic characteristics of fungal isolates of spoilt tomatoes from Adeyemi Student Market

Isolate	Texture	Type of hyphae	Color	Shape	Condiospore	Probable organism
1	Powdery	Septate	Dark	Circular	Branched	*Alternaria* spp.
2	Cottony	Septate	White	Round	Branched	*Penicillium* spp.

Table 7. Cultural and microscopic characteristics of fungal isolates of spoilt tomatoes from Iyalaje Market

Isolate	Texture	Type of hyphae	Color	Shape	Condiosphore	Probable organism
1	Powdery	Septate	White	Round	Branched	*Penicillium* spp
2	Cottony	Septate	Yellow-green	Round	Non-branched	*Aspergillus* spp.

Table 8. Frequency of occurrence of the bacteria isolated from spoilt tomatoes

Bacterial Isolates	No. of occurrence	% of occurrence
Bacillus spp	2	10
Enterobacter spp.	2	10
Escherichia coli	4	20
Klebsiella spp.	2	10
Proteus spp.	1	5
Pseudomonas spp	1	5
Salmonella spp.	1	5
Shigella spp	2	10
Staphylococcus spp,	5	25

Table 9. Frequency of occurrence of fungi isolated from spoilt tomatoes

Fungal isolates	No. of isolates	% of isolates
Alternaria spp.	4	44.4
Aspergillus spp.	2	22.2
Penicillium spp.	1	11.1
Rhizopus spp.	2	22.2

Table 10. Antibiotic susceptibility profile ~~for~~ of the Gram-negative bacteria isolated from spoilt tomatoes obtained from Odoshida market

Organisms	Antibiotics	Zone of inhibition (mm)	Resistant/ Intermediate/ Susceptible
Enterobacter spp.	OFX	0.00 ± 0.00	Resistant
	PEF	7.75 ± 3.18	Resistant
	CPX	18.00 ± 2.82	Intermediate
	AU	0.00 ± 0.00	Resistant
	CN	0.00 ± 0.00	Resistant
	S	13.00 ± 1.41	Intermediate
	CEP	0.00 ± 0.00	Resistant
	NA	0.00 ± 0.00	Resistant
	SXT	10.25 ± 3.89	Resistant
	PN	0.00 ± 0.00	Resistant
Proteus spp.	OFX	12.25 ± 0.35	Susceptible
	PEF	7.00 ± 1.41	Resistant
	CPX	17.50 ± 1.41	Susceptible
	AU	8.25 ± 1.06	Resistant
	CN	18.50 ± 0.71	Susceptible
	S	14.75 ± 1.77	Susceptible
	CEP	0.00 ± 0.00	Resistant
	NA	0.00 ± 0.00	Resistant
	SXT	14.00 ± 1.41	Intermediate
	PN	0.00 ± 0.00	Resistant
Salmonella spp.	OFX	0.00 ± 0.00	Resistant
	PEF	10.00 ± 5.66	Intermediate
	CPX	14.00 ± 1.41	Intermediate
	AU	0.00 ± 0.00	Resistant
	CN	0.00 ± 0.00	Resistant
	S	0.00 ± 0.00	Resistant
	CEP	0.00 ± 0.00	Resistant
	NA	0.00 ± 0.00	Resistant
	SXT	14.25 ± 3.18	Intermediate
	PN	0.00 ± 0.00	Resistant

Key: *OFX- Tarivid; PEF- Reflacine; CPX- Ciproflox; AU- Augmentin; CN- Gentamycin; S- Streptomycin; CEP- Ceporex; NA- Nalidixic acid; SXT- Septrin; PN-Ampillicin*

Table 11. Antibiotic susceptibility profile of the Gram-negative bacteria isolated from spoilt tomatoes obtained from Adeyemi student market

Organisms	Antibiotics	Zone of inhibition (mm)	Resistant/ Intermediate/ Susceptible
Klebsiella spp.	OFX	0.00 ± 0.00	Resistant
	PEF	0.00 ± 0.00	Resistant
	CPX	14.75 ± 0.35	Susceptible
	AU	0.00 ± 0.00	Resistant
	CN	19.50 ± 1.41	Susceptible
	S	13.25 ± 1.06	Intermediate
	CEP	0.00 ± 0.00	Resistant
	NA	0.00 ± 0.00	Resistant
	SXT	15.25 ± 3.89	Susceptible
	PN	0.00 ± 0.00	Resistant
Escherichia coli	OFX	0.00 ± 0.00	Resistant
	PEF	15.75 ± 1.06	Intermediate
	CPX	15.00 ± 0.71	Susceptible
	AU	0.00 ± 0.00	Resistant
	CN	11.50 ± 2.82	Resistant
	S	21.00 ± 5.66	Susceptible
	CEP	0.00 ± 0.00	Resistant
	NA	0.00 ± 0.00	Resistant
	SXT	0.00 ± 0.00	Resistant
	PN	0.00 ± 0.00	Resistant
Shigella spp.	OFX	0.00 ± 0.00	Resistant
	PEF	5.50 ± 0.71	Resistant
	CPX	9.75 ± 5.30	Resistant
	AU	0.00 ± 0.00	Resistant
	CN	0.00 ± 0.00	Resistant
	S	0.00 ± 0.00	Resistant
	CEP	0.00 ± 0.00	Resistant
	NA	0.00 ± 0.00	Resistant
	SXT	15.75 ± 1.06	Susceptible
	PN	0.00 ± 0.00	Resistant

Key: *OFX- Tarivid; PEF- Reflacine; CPX- Ciproflox; AU- Augmentin; CN- Gentamycin; S- Streptomycin; CEP- Ceporex; NA- Nalidixic acid; SXT- Septrin; PN-Ampicillin*

Table 12. Antibiotic susceptibility profile of the Gram-negative bacteria isolated from spoilt tomatoes obtained from Iyalaje market

Organisms	Antibiotics	Zone of inhibition (mm)	Resistant/ Intermediate/ Susceptible
Pseudomonas spp.	OFX	0.00 ± 0.00	Resistant
	PEF	0.00 ± 0.00	Resistant
	CPX	15.00 ± 0.00	Intermediate
	AU	0.00 ± 0.00	Resistant
	CN	20.50 ± 0.71	Susceptible
	S	0.00 ± 0.00	Resistant
	CEP	0.00 ± 0.00	Resistant
	NA	0.00 ± 0.00	Resistant
	SXT	17.50 ± 0.71	Susceptible
	PN	0.00 ± 0.00	Resistant
Klebsiella spp.	OFX	0.00 ± 0.00	Resistant
	PEF	0.00 ± 0.00	Resistant
	CPX	14.75 ± 0.35	Susceptible
	AU	0.00 ± 0.00	Resistant
	CN	19.50 ± 1.41	Susceptible
	S	13.25 ± 1.06	Intermediate
	CEP	0.00 ± 0.00	Resistant
	NA	0.00 ± 0.00	Resistant
	SXT	15.25 ± 3.89	Susceptible
	PN	0.00 ± 0.00	Resistant
Enterobacter spp.	OFX	0.00 ± 0.00	Resistant
	PEF	7.75 ± 3.18	Resistant
	CPX	18.00 ± 2.82	Susceptible
	AU	0.00 ± 0.00	Resistant
	CN	0.00 ± 0.00	Resistant
	S	13.00 ± 1.41	Intermediate
	CEP	0.00 ± 0.00	Resistant
	NA	0.00 ± 0.00	Resistant
	SXT	10.25± 3.89	Resistant
	PN	0.00 ± 0.00	Resistant
Escherichia coli	OFX	0.00 ± 0.00	Resistant
	PEF	5.75 ± 1.06	Resistant
	CPX	11.25 ± 6.01	Resistant
	AU	0.00 ± 0.00	Resistant
	CN	11.50 ± 2.82	Intermediate
	S	21.00± 5.66	Susceptible
	CEP	0.00 ± 0.00	Resistant
	NA	0.00 ± 0.00	Resistant
	SXT	0.00 ± 0.00	Resistant
	PN	0.00 ± 0.00	Resistant

Key: *OFX- Tarivid; PEF- Reflacine; CPX- Ciproflox; AU- Augmentin; CN- Gentamycin; S- Streptomycin; CEP- Ceporex; NA- Nalidixic acid; SXT- Septrin; PN-Ampicillin*

Table 13. Antibiotic susceptibility profile of the Gram-positive bacteria isolated from spoilt tomatoes obtained from Odoshida market

Organism	Antibiotics	Zone of inhibition (mm)	Resistant/ Intermediate/ Susceptibility
Staphylococcus spp.	CPX	0.00 ± 0.00	Resistant
	NB	10.50 ± 2.83	Resistant
	CN	16.5 ± 0.71	Susceptible
	AMX	0.00 ± 0.00	Resistant
	S	7.00 ± 0.71	Resistant
	RD	14.75 ± 1.06	Resistant
	E	10.75 ± 6.72	Resistant
	CH	6.50 ± 1.41	Resistant
	APX	0.00 ± 0.00	Resistant
	LEV	18.00 ± 1.41	Susceptible
Bacillus spp.	CPX	0.00 ± 0.00	Resistant
	NB	0.00 ± 0.00	Resistant
	CN	16.50 ± 0.71	Susceptible
	AMX	0.00 ± 0.00	Resistant
	S	10.00 ± 3.50	Resistant
	RD	14.75 ± 1.06	Intermediate
	E	6.75 ± 1.06	Resistant
	CH	10.50 ± 0.71	Resistant
	APX	0.00 ± 0.00	Resistant
	LEV	18.00 ± 1.41	Susceptible

Key: *CPX- Ciproflox; NB- Norfloxacin; CN- Gentamycin; AMX- Amoxil; S- Streptomycin; RD-Rifampicin; E-Erythromycin; CH-Chloramphenicol; APX- Ampiclox; LEV- Levofloxacin*

Table 14. Antibiotics susceptibility profile ~~for~~ of the Gram-positive bacteria isolated from spoilt tomatoes obtained from Adeyemi student market

Organism	Antibiotics	Zone of inhibition (mm)	Resistant/ Intermediate/ Susceptibility
Bacillus spp.	CPX	0.00 ± 0.00	Resistant
	NB	0.00 ± 0.00	Resistant
	CN	16.50 ± 1.41	Susceptible
	AMX	0.00 ± 0.00	Resistant
	S	0.00 ± 0.00	Resistant
	RD	17.25 ± 1.06	Intermediate
	E	0.00 ± 0.00	Resistant
	CH	16.00 ± 2.12	Intermediate
	APX	0.00 ± 0.00	Resistant
	LEV	18.50 ± 0.71	Susceptible

Key: *CPX- Ciproflox; NB- Norfloxacin; CN- Gentamycin; AMX- Amoxil; S- Streptomycin; RD-Rifampicin; E-Erythromycin; CH-Chloramphenicol; APX- Ampiclox; LEV- Levofloxacin*

Table 15. Antibiotics susceptibility profile of the Gram-positive bacteria isolated from spoilt tomatoes obtained from Iyalaje market

Organisms		Antibiotics	Zone of inhibition (mm)	Resistant/ Intermediate/ Susceptibility
Staphyl ococcus spp.	CPX	0.00 ± 0.00	Resistant	Resistant
	NB	0.00 ± 0.00	Resistant	Resistant
	CN	16.25 ±1.06	Susceptible	Susceptible
	AMX	0.00 ± 0.00	Resistant	Resistant
	S	11.75 ± 6.01	Resistant	Resistant
	RD	15.50 ± 0.00	Intermediate	Intermediate
	E	0.00 ± 0.00	Resistant	Resistant
	CH	9.25 ± 5.30	Resistant	Resistant
	APX	0.00 ± 0.00	Resistant	Resistant
	LEV	16.75 ± 3.18	Susceptible	Susceptible

Key: *CPX- Ciproflox; NB- Norfloxacin; CN- Gentamycin; AMX- Amoxil; S- Streptomycin; RD-Rifampicin; E-Erythromycin; CH- Chloramphenicol; APX- Ampiclox; LEV- Levofloxacin*

CONCLUSION

The study has shown that Gram-positive and Gram-negative bacterial species as well as different species of fungi may be involved in the spoilage of tomatoes and this could pose danger to public health. Public awareness is therefore advocated to educate the populace on the inherent dangers in consumption of spoilt tomatoes. Government should also make provision for proper waste management.

RECOMMENDATION

It is recommended that spoilt tomatoes should be consumed with caution. Good personal hygiene and better packaging and means of transportation should also be observed.

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