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MICROBIOLOGICAL EVALUATION OF SPOILT TOMATO (*Lycopersicum esculentum*) AND PEPPER (*Capsicum Spp*) SOLD IN MANDATE MARKET, ILORIN, KWARA STATE, NIGERIA

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ABSTRACT

Tomato and pepper contribute significantly to diet as they are used as ingredients in food preparation. This study evaluated microbiological quality of spoilt tomato and pepper sold in Mandate Market using standard microbiological methods. Results of analysis of variance (ANOVA) showed that there were significant ($p < 0.05$) differences in total heterotrophic bacteria count (THBC), total coliform counts (TCC) and total fungal counts (TFC) of the samples under study. The results from spoilt tomato samples showed that THBC ranged from $1.7 \pm 0.07\times10^4$ CFU/ml - $9.5\pm0.21\times10^4$CFU/ml, TCC from 0.0×10^4 CFU/100ml - 9.0×10^4 CFU/100ml, while TFC ranged from $1.1 \pm 0.4\times10^4$ CFU/g - $4.1 \pm1.27 \times10^4$ CFU/g. THBC of spoilt pepper ranged from $1.7 \pm 0.28 \times 10^4$ CFC/ml - $8.8\pm 0.21 \times 10^4$ CFC/ml. TCC was between 0.0×10^4CFU/ml and $6.0\pm 1.41 \times10^4$ CFU/ml while TFC ranged from 1.5 ± 0.28 CFU/g - $5.5 \pm 0.35 \times10^4$ CFU/g. The probable microorganisms present in spoilt tomato samples include, *pseudomonas vulgaris, pseudomonas aeruginosa, staphylococcus aureus, bacillus subtilis, Escherichia coli, C. freundi, Penicillium chrysogenum, Saccharomyces cerevisiae, Aspergillus niger* and *Rhizopus stolonifer*. In addition, microorganisms identified from spoilt pepper samples were *Clostridium sp, Pseudomonas aeruginosa, Staphylococcus aureus, Salmonella sp, E. coli, Aspergillus niger, Fusarium oxysporum, Penicillium* sp. and *Aspergillus fumigatus*. The study revealed that *E. coli* and *Staphylococcus aureus* dominated spoilt tomato and pepper with prevalence of 33.4 % and 28.6 % respectively. Results on the survey showed poor handling, storage and hygienic practices of tomato and pepper vendors in Mandate Market.

Contribution/Originality: This study showed the probable identity of microorganisms associated in spoilt tomato and pepper samples sold in Mandate market, Kwara State, the percentage occurrence of microorganisms as well as handling, storage and hygienic practices of vendors in the market.

1. INTRODUCTION

Tomato (*Lycopersicum esculentum*), a climacteric fruit belongs to the plant family *solanaceae* [1]. The fruit originated from South America and according to Wamache [2] the colonial settlers introduced tomato to East Africa in early 1900. Tomato is a widely consumed fruit eaten in both raw and processed forms [1]. Tomato provides considerable amounts of nutrients needed for growth. Studies have reported that tomato is rich in iron, calcium, phosphorus, Vitamins A and C, as well as carbohydrates Udoh, et al. [3]; Nnenna and Briggs [4]. Campbell [5] stated that tomato fruit is one of the most perishable vegetables. In addition, Wogu and Ofuase [6] opined that it perishability is due to high moisture content contained in the fruit. The high moisture content of tomatoes makes it more susceptible to spoilage by the action of microorganisms [4, 6, 7] and other physical agents.

Pepper (*Capsicum* spp) also belongs to the family *Solanaceae* [8]. It is one of the cultivated crops around the world that provides an important source of income for small producers in many developing countries [8]. The uniqueness of pepper is the typical pungency due to the presence of capsaicinoids. Pepper contributes significant amount of vitamins and minerals to the diet [4] and as such use as ingredient in food preparation.

In Nigeria, tomato and pepper are predominantly grown in the northern region and the produce marketed in the southern region of the country. Freshly harvested tomato fruits and pepper are stored, conveyed and marketed in raffia baskets. These baskets are often used until they become infected with microorganisms. Again it may take days for the produce to reach the market due to poor road network and vehicle breakdown. All these factors contribute to spoilage of freshly harvested tomato and pepper.

Currently, a basket of tomatoes and pepper are sold at a relatively high price as compared to what it used to be in the last two years. In addition tomatoes and pepper dealer tend to sell the spoilt product at a giveaway price. Consequently, most food vendors on the other hand tend to buy the spoilt tomatoes and pepper for their vending activities without minding public health implication. However, even though the vegetative cell of the spoilage organisms may be destroyed during cooking, the spores and toxins are still present therein and on consumption of such food can result in food intoxication and poisoning. Frimpong, et al. [8] reported that most mycotoxins are chemically and thermally stable and cannot be destroyed during most food processing operations.

To the best of our knowledge, studies on isolation and identification of microorganisms associated with spoiled tomatoes and pepper sold at Mandate Market, Ilorin, Kwara State has received little or no attention; thus this study forms a basis for justification of the study. It is therefore important to isolate and identify microorganisms associated with spoilt tomatoes and pepper, the relationship between their occurrence and the hygienic and storage practices of the vendors in order to create public awareness and to avert food poisoning and intoxication.

2. MATERIALS AND METHODS

2.1. Sample Collection

A total of twenty (20) samples comprising ten (10) samples each of spoiled tomatoes and pepper were collected in sterile packages. It was transported without delay to the laboratory in aseptic conditions within one to two hours of collection for microbial analysis.

2.2. Preparation of Culture Media

Media such as nutrient agar (NA) and potato dextrose agar (PDA) were prepared according to manufacturers' specifications.

2.3. Sterilization of Materials

The method of Elijah, et al. [9] was adopted. All materials were adequately and appropriately sterilized before and after use. Glass wares were soaked and washed thoroughly with detergent and rinsed with distilled water properly and drained. They were wrapped with aluminum foil paper and dried in the oven in inverted position at 180 °C for 60 min.

The working area was swabbed with ethanol. Contamination by microorganisms from the external environment was reduced by closing windows and putting off fans in the laboratory. Prepared media and distilled water was autoclaved at 121°C for about 30 min at 15 psi (per square inch). Metal equipment like the inoculating loop was heated to redness in an open flame before and after use. Every isolation and inoculation was done near the flame to reduce contamination of the agar plates tube.

2.4. Sample Preparation

Sample preparation was done following the method reported by Wogu and Ofuase [6]. The spoiled tomato and pepper samples were ground separately using a sterile mortar and pestle. A homogenate of each sample was made by blending one gram in 9ml of sterile water and shaking them together. Serial dilutions of up to 10^3 of the homogenate were made in sterile test tubes. 1ml of the serially diluted tomato sample was pipetted into each serially marked petri dish.

2.5. Isolation of Microorganisms

The method of Wogu and Ofuase [6] was adopted. Total microbial count was carried out on the samples using the pour plate method. Nutrient agar and potato dextrose agar were used for bacteria and fungi respectively. The plates were subsequently incubated at 37 °C for 24 hours for bacteria and 72 hours for fungi. At the end of incubation, developed colonies were counted and recorded.

2.6. Characterization and Identification of Isolates

Discrete colonies that developed after incubation were sub-cultured to obtain pure cultures which were stored at 4 °C and used subsequently for microscopic characterization and biochemical analyses. The distinct colonies that developed in the pure culture plates were observed for the morphological and cultural characteristics including the nature of margin, elevation, shape, colour and transparency. The isolates were further characterized and identified following biochemical procedures as described by Harrigan and McCane [10] and Holt, et al. [11]. Fungal isolates were identified using colonial appearance and microscopic characteristics [12, 13].

2.7. Survey of Handling, Storage and Hygienic Practices of Tomato and Pepper Vendors

Questionnaires topics on different aspects of food safety, handling and hygienic practices were given to 11 vendors according to the method of Elijah, et al. [9] with slight modifications.

2.8. Statistical Analysis

Data obtained from microbial counts were subjected to analysis of variance (ANOVA). Where differences exist between the means, this was separated using Duncan's multiple range test of the IBM SPSS software version 20. Significant differences were expressed at 5% level of probability.

Table 1. Total heterotrophic bacteria, coliforms and fungal counts of spoilt tomatoes.

Samples	Dilution factor	THBC×10^4CFU/ml	TCC×10^4CFU/100ml	TFC×10^4CFU/g
S_1	10^3	$8.1^b \pm 0.35$	$2.5^d \pm 0.71$	$2.5^{bc} \pm 0.99$
S_2	10^3	$5.0^c \pm 0.35$	$5.0^c \pm 1.41$	$2.4^{bc} \pm 0.64$
S_3	10^3	$6.2^c \pm 0.21$	$9.0^a \pm 1.41$	$3.2^{ab} \pm 0.85$
S_4	10^3	$9.5^a \pm 0.28$	$7.5^{ab} \pm 0.71$	$4.1^a \pm 1.27$
S_5	10^3	$3.7^d \pm 0.23$	$6.0^{ab} \pm 1.41$	$2.4^{bc} \pm 0.14$
S_6	10^3	$2.4^{de} \pm 0.21$	$0.0^e \pm 0.00$	$1.1^c \pm 0.14$
S_7	10^3	$3.0^{de} \pm 1.63$	$2.0^{d\pm}$ 0.00	$1.2^c \pm 0.14$
S_8	10^3	$1.7^e \pm 0.07$	$2.5^d \pm 0.71$	$1.7^{bc} \pm 0.07$
S_9	10^3	$2.7^{de} \pm 0.23$	$0.00^e \pm 0.00$	$1.4^c \pm 0.14$
S_{10}	10^3	$1.7^e \pm 0.14$	$0.00^e \pm 0.00$	$1.3^c \pm 0.00$

Note: Values are means SD of triplicate determinations. Means in the same column with different superscripts are significantly ($p<0.05$) different.

3. RESULTS AND DISCUSSION

3.1. Microbial Counts of Spoilt Tomato and Pepper

The results of the total heterotrophic bacterial counts (THBC), total coliform counts (TCC) and total fungal counts (TFC) of the spoilt tomatoes samples are shown in Table 1. The results showed that THBC ranged from 1.7 ± 0.07×10^4 CFU/ml - 9.5±0.21×10^4CFU/ml, TCC from 0.0×10^4 CFU/100ml - 9.0×10^4 CFU/100ml, while TFC was found to be from 1.1 ± 0.4×10^4 CFU/g - 4.1 ±1.27 ×10^4 CFU/g.

There were significant ($p < 0.05$) differences in THBC, TCC and TFC. Table 1 showed that the highest THBC was obtained in spoilt tomato sample S_4 having a value of 9.5 ±0.21×10^4 CFU/mL and was significantly different from other samples. This was followed by sample S_1 with a value of 8.1 ±0.35×10^4 CFU/ml. The least THBC was obtained in sample S_{10} with value1.7±0.14×10^4 CFU/ml and which was not significantly different from samples S_6, S_7, S_8 and S_9. The values of THBC obtained in this study are higher than the values reported by Wogu and Ofuase [6] as mean bacterial counts to be between 2.0-35.0×10^3 CFU/ml. The difference in THBC could be attributed to differences in the levels of proliferation by the contaminating organisms, source of farm product or wholesale points of purchase [14].

The total coliform counts Table 1 indicated sample S_3 (9.0±1.41×10^4CFU/ml) to be significantly different from other samples except samples S_4 and S_5. In addition, samples S_6, S_9 and S_{10} were not significantly different ($p > 0.05$). The least TCC was recorded in samples S_6, S_9 and S_{10} with a value of 0 CFU/ml each.

Similarly, Table 1 also revealed significant differences in total fungal count in the spoilt tomato samples. The highest count (4.1±1.27×10^4CFU/ml) was obtained in sample S_4 which was not significantly different ($p>0.05$) from sample S_3 (3.2±0.85×10^4 CFU/g). Table 1 also revealed that sample S_6 was not significantly different ($p>0.5$) from samples S_1, S_2, S_5, S_7, S_8, S_9 and S_{10}. As reported by Obeng, et al. [14] the differences in microbial load could be as a result of sources of farm were the produce are harvested, storage materials and markets, among others. In addition, mechanical injury during handling and transportation of the produce could predispose the produce to microbial proliferation.

The results of the total heterotrophic bacteria count (THBC), total coliform counts (TCC) and total fungal counts (TFC) of spoilt pepper samples are presented in Table 2. Table 2 shows that THBC of spoilt pepper obtained were from 1.7 ± 0.28 × 10^4 CFC/ml - 8.8± 0.21 × 10^4. The highest THBC (8.85±0.21×10^4CFU/ml) was obtained in sample F_3 which was not significantly different ($p < 0.05$) from sample F_2 (8.7±0.28×10^4CFU/ml) but was significantly different ($p<0.05$) from other samples. TCC was between 0.0×10^4CFU/ml and 6.0± 1.41 ×10^4 CFU/ml. Results showed that significant differences exist among the spoilt pepper samples.

Table 2. Total heterotrophic bacteria, coliforms and fungi counts of spoilt pepper.

Samples	Dilution factors	THBC×10^4CF/ml	TCC×10^4 CFU/ml	TFC×10^4CFU/g
F_1	10^3	6.3 ^{b} ± 0.35	3.5 ^{bc}±0.71	4.8 ^{b} ± 0.21
F_2	10_3	8.6 ^{a} ± 0.28	3.0 ^{cd} ± 0.00	3.1 ^{d} ± 0.21
F_3	10^3	8.85 ^{a} ± 0.28	5.0 ^{ab} ±1.41	3.6 ^{c} ± 0.07
F_4	10^3	4.3 ^{d} ± 0.21	6.0 ^{a} ± 1.41	4.4 ^{b} ± 0.14
F_5	10^3	5.0 ^{c} ± 0.21	5.0 ^{ab}±1.41	5.5 ^{a} ± 0.35
F_6	10^3	2.2 ^{f} ± 0.14	0.0 ^{e} ± 0.00	1.5 ^{f} ± 0.14
F_7	10^3	1.7 ^{f} ±0.28	2.0 ^{de}± 0.000	2.0 ^{e} ± 0.28
F_8	10^3	2.0 ^{f} ± 0.14	0.00^e ±0.00	1.6 ^{ef} ± 0.14
F_9	10^3	2.9 ^{e} ± 0.28	0.0 ^{e} ±0.00	1.9 ^{ef} ± 0.14
F_{10}	10^3	3.0 ^{e} ± 0.21	1.5^{de}±0.71	2.1 ^{e} ± 0.14

Note: Values are means SD of triplicate determinations. Means in the same column with different superscripts are significantly ($p<0.05$) different.

TFC was found to be from 1.5 ± 0.28 CFU/g - 5.5 ± 0.35 ×10^4 CFU/g. Similarly, there was significant difference ($p < 0.05$) in fungal counts among the spoilt pepper samples. The highest value of 5.5±0.35×10^4CFU/g was recorded in sample F_5 and was significantly different from all other samples. This was followed by samples F_1 (4.8±0.21×10^4CFU/g) and F_4 (4.4±0.14×10^4 CFU/g) which was not significantly different from each other. The least fungal counts were obtained in sample F_6 ($1.5\pm0.28\times10^4$ CFU/g) which was not significantly different from samples F_8 and F_9. Variations in counts could be as a result of level of microbial proliferation, handling and hygienic practices of the vendors.

Table 3. Morphological and biochemical characterization of bacterial species in spoilt tomatoes.

Morphology/ biochemical tests	**Probable Identity of Bacteria isolates**					
	P. vulgaris	***P. aeruginosa***	***S. aureus***	***B. subtilis***	***E. coli***	***C. freundi***
Shape	**Cocci**	**Bacilli**	**Cocci**	**Bacilli**	**Bacilli**	**Bacilli**
Cell arrangement	**Single**	**Single**	**Irregular/ Clusters**	**Pairs/ Chains**	**Single**	**Single**
Pigmentation	-	+	-	-	-	-
Gram reaction	-	-	+	+	-	-
Motility	+	+	-	+	+	+
Endospore	-	-	-	+	-	-
Catalase	+	+	+	+	+	+
Oxidase	-	+	-	-	-	+
Coagulase	-	-	+	-	-	-
Indole	+	-	-	-	-	-
Citrate utilization	+	+	+	+	-	+
MR	+	-	-	-	+	+
VP	-	-	+	+	-	-
Gelatinase	+	-	+	+	-	-
Ureases	+	+	+	-	-	+
Tipple sugar Glu	+	-	+	+	+	+
Lactose	-	-	+	-	+	+
Sucrose	+	-	+	+	+	+
Starch	-	-	-	+	-	-
H_2S	+	-	-	-	-	+
Gas production	+	+	-	-	+	+
O_2 relationship	FA	FA	FA	OA	FA	FA

Note: + = positive - = negative FA = facultative anaerobe OA = obligate anaerobe, Glu = Glucose.

Table 4. Morphological and biological characteristics of bacterial species isolated from spoilt pepper.

Morphology					
Shape	**Cocci**	**Bacilli**	**Cocci**	**Bacilli**	**Bacilli**
Cell arrangement	**Single**	**Single**	**Irregular/ Clusters**	**Single**	**Single**
Pigmentation	-	+	-	-	-
Gram reaction	-	-	+	-	-
Biochemical Tests					
Motility	+	+	-	+	+
Endospore	-	-	-	-	-
Catalase	+	+	+	+	+
Oxidase	-	+	-	-	-
Coagulase	-	-	+	-	-
Indole	+	-	-	-	-
Citrate utilization	+	+	+	-	-
MR	+	-	-	+	+
VP	-	-	+	-	-
Gelatinase	+	-	+	-	-
Urease	+	+	+	-	-
Tiple sugar Glucose	+	-	+	+	+
Lactose	-	-	+	-	+
Sucrose	+	-	+	-	+
Starch	-	-	-	-	-
H_2S	+	-	-	-	-
Gas production	+	+	-	-	+
O_2 relationship	FA	FA	FA	FA	FA
Probable Identity	*Clostridium*sp.	*P. aeruginosa*	*S. aureus*	*Salmonella* sp.	*E. coli*

Note: + = positive, - = negative, FA = facultative anaerobe.

3.2. Morphological and Biochemical Characterization of Bacteria Isolates in Spoilt Tomato and Pepper

The results of the morphological and biochemical characterization of bacterial species in spoilt tomatoes are presented in Table 3. The probable microorganisms present in spoilt tomato samples include, *pseudomonas vulgaris, pseudomonas aeruginosa, staphylococcus aureus, bacillus subtilis, Escherichia coli,* and *C. freundi.* Some of these microorganisms such as *E. coli Bacillus subtilis, Staphylococcus aureus, Pseudomonas sp* have been isolated in spoilt tomatoes by Mohammed and Kuhiyep [1]; Wogu and Ofuase [6]; Jushi and Patel [15] Thus, the findings in this study are in conformity with their previous works. The presence of some of the organisms such as E. coli, *Staphylococcus aureus* has been reported to be detrimental to human health [16, 17].

More so, the results of the morphological and biological characteristics of bacterial species isolated from spoilt pepper are shown in Table 4. The probable identities of microorganisms were *clostridium sp, pseudomonas aeruginosa, staphylococcus aureus, salmonella sp, E. coli.*

These organisms had previously been isolated from pepper by Tizhe, et al. [18]. The presence of *clostridium* in food sample if ingested had been reported to cause infections via production of toxin which are responsible for diarrhea [18, 19]. The presence of *salmonella sp* and *E. coli* at elevated amount is one of the leading causes of food infections and intoxication if ingested by humans. Thus, the organisms identified in this study are in conformity with the reports of Tizhe, et al. [18] and that of Nnenna and Briggs [4].

3.3. Percentage Prevalence of Bacterial Isolates in Spoilt Tomato and Pepper

The percentage prevalence of bacterial isolates in spoilt tomato samples are presented in Table 5. Results in Table 5 revealed that the least occurrence was *C. freundi* (5.6 %) while the highest occurrence (33.4%) was *E. coli.* In addition, the percentage occurrence of the prevalence bacterial isolates from spoilt pepper is shown in Table 6. Results in Table 6 showed that *Salmonella sp* (8.6%) recorded the least prevalence percentage, while, *Staphylococcus aureus* (28.6%) was the most prevalence bacteria isolated in spoilt pepper.

Table 5. Percentage prevalence of bacterial isolates in spoilt tomatoes.

Bacteria	Frequency	Prevalence (%)
P. vulgaris	4	11.1
P.aeruginosa	7	19.4
S. aureus	8	22.2
B. subtilis	3	8.3
E. coli	12	33.4
C. freundii	2	5.6
Total	36	100

Table 6. Percentage occurrence of the prevalence bacterial isolates from spoilt pepper.

Bacteria	Frequency	Prevalence (%)
Clostridium sp.	6	17.1
P.aeruginosa	7	20.0
S. aureus	10	28.6
Salmonella sp.	3	8.6
E. coli	9	25.7
Total	35	100

3.4. Mycological Results

3.4.1. Photomicrographs of Fungal Isolates from Spoilt Tomato and Pepper

The photomicrographs of fungal isolates from spoilt tomato and pepper are presented in Figure 1. Microorganisms such as *Penicillium chrysogenum, Saccharomyces cerevisiae, Aspergillus niger* and *Rhizopus stolonifer* were identified from spoilt tomato samples, while *Aspergillus niger, Fusarium oxysporum, Penicillium* sp. and *Aspergillus fumigatus* were isolated in spoilt pepper samples.

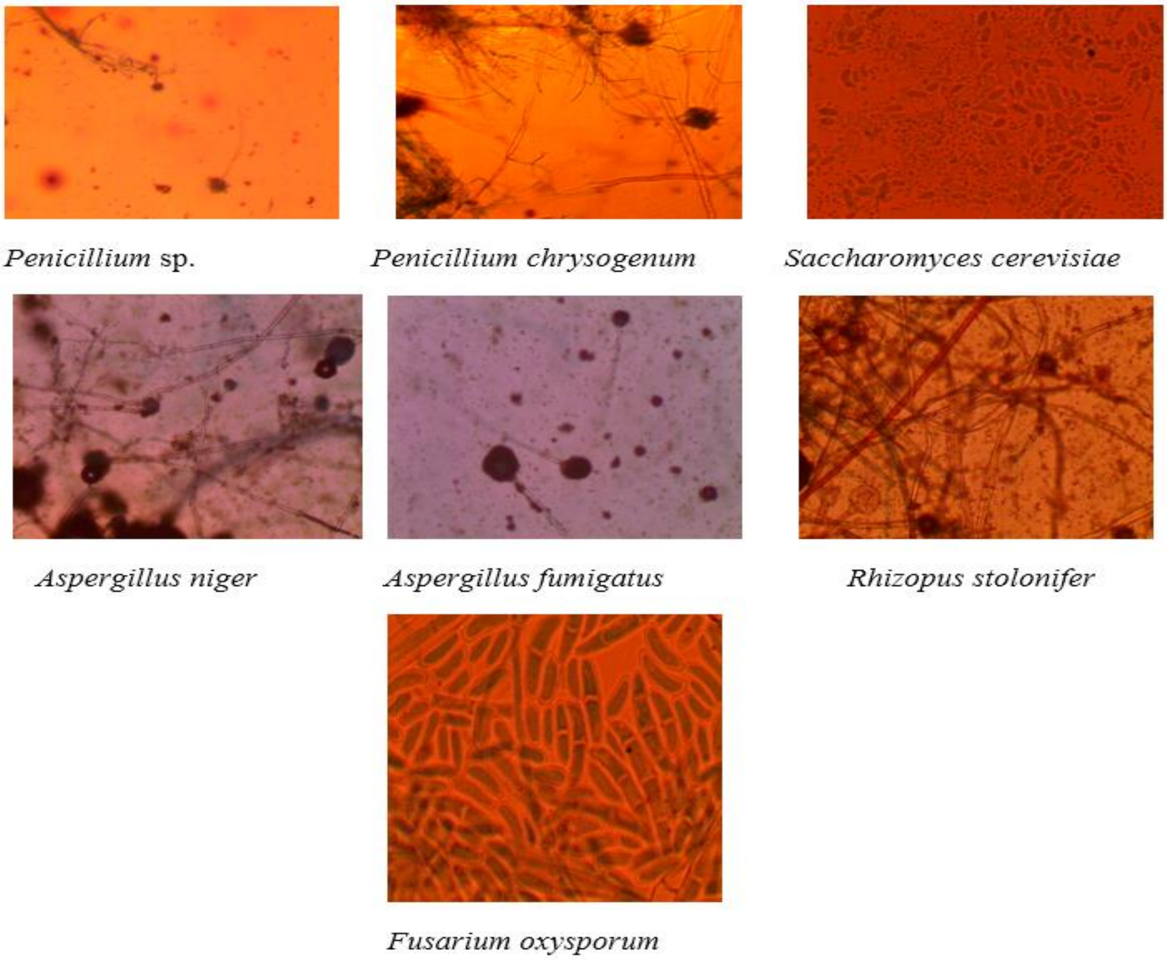

Figure 1. Photomicrographs of fungi isolated from spoilt tomato and pepper samples.

3.4.2. Percentage Prevalence of Fungal Isolates in Spoilt Tomato and Pepper

The predominant fungi was *Saccharomyces cerevisae*, (37.5%) while *Aspergillus niger* (12.5%) was the least dominant fungi associated in spoilt tomato samples (Table 7). Also, the percentage prevalence fungi isolate in spoilt pepper are shown in Table 8. Results in Table 8 showed that spoilt pepper was predominated by *Aspergillus fumigatus* (36.3%). The least occurrences were *Fusarium oxysporum and Penicillium* sp. with each having 18.2% occurrences. The predominance of *Aspergillus fumigatus* in this study conforms to the report of Tsado, et al. [20] who reported *Asperigillus fumigates* as the most isolated fungi in pepper sample. In addition, Ghosh [21] opined that *Aspergillus niger*, *Fusarium* and *Penicillium* to be the major cause of damage to the tomato fruit.

Table 7. Percentage prevalence of fungal isolates in spoilt tomato samples.

Isolate	*P. chrysogenum*	*S. cerevisiae*	*A. niger*	*R. stolonifer*	Total
Frequency (%)	2 (25.0)	3 (37.5)	1 (12.5)	2 (25.9)	8 (100)

Table 8. Percentage prevalence of fungal isolates in spoilt pepper.

Isolate	Frequency	Prevalence (%)
Aspergillus niger	3	27.3
Fusarium oxysporum	2	18.2
Aspergillus fumigatus	4	36.3
Penicillium sp.	2	18.2
Total	11	100.0

The identified fungi (*P. chrysogenum S. cerevisiae A. niger R. stolonifer, Fusarium oxysporum* and *Penicillium* sp.) in this study are in agreement with the findings reported by Ghosh [21] and Wogu and Ofuase [6]. They asserted that *Aspergillus niger, Fusarium* sp. and *Penicillium* sp. were the major microorganisms that are responsible for the spoilage of tomato fruits. Furthermore, the authors maintained that fungi were the source of spoilage of most tomato fruit samples assessed rather than bacteria. Akinmusire [22] reported that *Fusarium oxysporum, Rhizopus stolonifer* and *Mucor* sp. were the fungi species responsible for the spoilage of tomato fruits from three selected markets in Maiduguri, north eastern Nigeria. Al-Hindi, et al. [23] reported that the main tomato fruit spoilage fungi were *Aspergillus phoenicis.* They concluded that fungal polygalacturonases and xylanases were the main enzymes responsible for the spoilage of these produce. However, Ojo, et al. [24] reported *Aspergillus niger, yeast* and *Penicillium* sp. as the major organisms in pepper samples. Mbajiuka and Enya [25] added that some species of *Aspergillus* and *Penicillium* are major producers of aflatoxin and mycotoxin as well as stomach inflammation. Thus ingestion of these organisms may be detrimental to health.

3.5. Handling, Storage and Hygienic Practices of Tomato and Pepper Vendors

Results on the survey of handling, storage and hygienic practices of tomato and pepper vendors are shown in Table 9- 11. The result on the profile of tomato vendors Table 9 showed that tomatoes trade was solely carried out by men and which predominantly are Hausa men. The study revealed (100%) of men involved in the business. About 72.7% of these men are in the age range of 35-44 years, while 27.3% are in the age bracket of 45-54 years. The study also revealed that 18.1% of these men had no formal education, 27.3% had primary education only while 45.5% had secondary education. Only 9.19% of these men attended colleges. In addition, 9.1%, 9.1%, 18.1%, 36.4% and 27.35 % of these men have been in tomato trade business for; 1-2years, 3-5years, 6-9years, 10-15years and over 16 years respectively.

This study showed poor handling, packaging and storage practices at Mandate Market, Ilorin. About 90.9% of these produce (tomatoes and pepper) were not protected from direct sunlight, while only 9.1% were protected from sun Table 10. Exposure of the harvested produce to direct sunlight will lead to increase respiration which resulted in increased metabolic activities and subsequent deterioration of the harvested produce.

Table 9. Profile of tomatoes and pepper in Mandate Market (n=11).

Parameter	Frequency (%)
General information	
Gender	
Male	11 (100)
Female	0
Age range	
15-24	0
25-34	0
35-44	8 (72.7)
45-54	3 (27.3)
55 and above	0
Level of Education	
No formal Education	2 (18.1)
Primary Education	3 (27.3)
Secondary Education	5 (45.5)
College	1 (9.1)
Period in Business	
< 1 year	0
1-2 years	1 (9.1)
3-5 years	1 (9.1)
6-9 years	2 (18.1)
10-15 years	4 (36.4)
15 years and above	3 (27.3)

Although 90.9% of tomatoes and pepper were packed in ventilated containers such as plastic basket (9.1%), basket made from palm front (72.7%) and jute bags (18.2%), a greater percentage of these containers (72.7%) were stacked on each other which predisposes the produce to mechanical injury. Results also shown that the packaging containers did not protect the harvested produce from mechanical injury as 63.6% of tomatoes and pepper were exposed to mechanical injury. This is because 81.8% of the produce was heaped together in a pile. Again, tomato and pepper were stored in an open (100%) with no controlled storage environment.

Table 10. The results shows the Handling, packaging and storage practices at Mandate Market (n=11).

Parameter	Frequency
Tomatoes and pepper from direct sunlight	
Yes	1 (9.1)
No	10 (90.9)
Tomatoes and pepper packed in ventilated containers	
Yes	10 (90.9)
No	1 (9.1)
Types of storage containers used	
Plastic basket	1 (9.1)
Basket made of palm front	8 (72. 7)
Jute bags	2 (18.2)
Others	0
Containers stacked on each other	
Yes	8 (72.7)
No	3 (27.3)
Are containers able to protect tomatoes and pepper from mechanical injury	
Yes	3 (27.3)
No	8 (72.7)
Are tomatoes and peppers heaped together in a pile?	
Yes	9 (81.8)
No	2 (18.2)
Are tomatoes and pepper stored in open or cold storage?	
Open storage	11 (100)
Refrigeration storage	0

Table 11. The results show the hygienic status of the vending Environment and waste disposal practices of tomato and pepper vendors in mandate market.

Parameter	Frequency (%)
Is vending stall protected from sun, dust and wind	
Yes	2 (18.2)
No	9 (81.8)
Environment around the stall clean, far from rubbish, waste water, toilet facilities, open drainage, etc	
Yes	7 (63.6)
No	4 (36.4)
Access to potable water at the site or close to the site	
Yes	2 (18.2)
No	9 (81.8)
Adequate hand washing facilities	
Yes	5 (45.5)
No	6 (54.5)
Availability of adequate waste disposal facilities	
Yes	5 (45.5)
No	6 (54.5)
How often are wastes disposed	
Once daily	0
Twice daily	0
Weekly	4 (36.4)
Monthly	7 (63.6)

The results of the handling, package and storage practices observed in this study is evident in the spoilage observed in those produce. Furthermore, the result of the hygienic status of the vending environment and waste disposal practices of tomato and pepper vendors showed that 81.8% of the vending stalls were not protected from sun, dust or wind Table 11. Only 18.2% of the stalls were protected from sun, dust and wind. About 63.6% of the environment around the stall was far from rubbish, waste water, toilet facilities, open drainage and animals, while 36.4% were close to waste materials.

It was revealed that only 18.2% of the vendors had access to potable water at the site or close to the site, while 81.8% did not have. Lack of potable water for the vendors to wash their hands as appropriate may lead to microbial spread and proliferation in/on the harvested produce. There was also lack of hand washing facilities (54.5%) in most stalls. Results on Table 11 also show that 54.5% of the vendors lack adequate waste disposal facilities, while the frequency of waste disposal shows 36.4% weekly and 63.6% monthly. Improper waste disposal can serve as source of cross contamination of tomatoes and pepper.

4. CONCLUSION

This study has clearly shown the presence of *pseudomonas vulgaris*, *pseudomonas aeruginosa*, *staphylococcus aureus*, *bacillus subtilis*, *Escherichia coli*, and *C. freundi*, *Salmonella*, *P. chrysogenum S. cerevisiae* *A. niger*, *A. fumigates*, *R. stolonifer*, *Fusarium* sp., *Clostridium* sp. and *Penicillium* sp. in spoilt tomato and pepper samples sold in Mandate market. On elevated amounts, these organisms are capable of causing human diseases if ingested. On the whole, the handling, storage and hygienic practices of vendors in this market are below standard. Hence, the need for public awareness so as to discourage the use of these spoilt produce in food preparation.

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