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Microbial analysis of fruit parfait sold around Ekiti State University

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Abstract
The microbial analysis of fruit parfaits sold around Ekiti State University (EKSU) is an essential investigation into the safety and quality of a popular ready-to-eat (RTE) snack. Fruit parfaits, typically consisting of layers of yogurt, granola, and fresh fruits, are highly nutritious but vulnerable to microbial contamination due to their perishable ingredients and minimal processing. This study aimed to assess the microbial load and identify potential pathogens in fruit parfaits sold by vendors around EKSU to ensure they are safe for consumption. Samples were collected from various vendors around the university and subjected to microbiological analysis to detect and quantify bacteria and fungi. Common microbial contaminants identified included *E. coli*, *Staphylococcus aureus*, *Candida tropicalis*, *Enterobacter aerogenes*, and *Bacillus lichenoformis*. The lowest microbial count was observed in Tasty Delight with a Total Microbial Load (CFU/ml) of 100, while the highest bacterial count was found in Tee's Pastries with a Total Microbial Load (CFU/ml) of 212,000. The most prevalent microbial contaminant was *Escherichia coli*, accounting for 26.67% of the isolates, followed by *Enterobacter aerogenes* and *Bacillus lichenoformis*, each comprising 20.00%. *Staphylococcus aureus* had the least occurrence at 13.33%.The detection of *E. coli* is especially worrisome, as it signifies fecal contamination and inadequate hygiene during preparation or handling. Similarly, *Staphylococcus aureus* poses a risk because it can produce enterotoxins responsible for foodborne illness, while *Candida tropicalis* can spoil the product and affect its shelf life. *Enterobacter aerogenes* and *Bacillus lichenoformis* are opportunistic pathogens that pose health risks, especially to immunocompromised individuals. Antibiotic resistance testing revealed that some isolates were highly resistant to Erythromycin and Cefazolin (60%), followed by resistance to Ciprofloxacin (53.33%). However, only a few isolates from the fruit parfaits were resistant to Gentamicin (13.33%). The identified species are suspected to be opportunistic pathogens, meaning they can cause infections and diseases when the host's immune system is weakened or compromised. The findings of this study underscore the need for strict adherence to food safety practices among vendors.

Keywords: Fruit parfait, microbial contamination, food safety, antibiotic resistance, pathogens

Introduction
Ekiti State University (EKSU), located in Ado-Ekiti, Nigeria, boasts a diverse student population with varying dietary needs and preferences. In recent years, fruit parfaits have become a popular food choice on campus, appreciated for their convenience, perceived health benefits, and visually appealing presentation [1]. Fruit parfaits, typically consisting of layers of yogurt, granola, and fresh fruits, are highly nutritious but vulnerable to microbial contamination due to their perishable ingredients and minimal processing. This study aims to assess the microbial load and identify potential pathogens in fruit parfaits sold by vendors around EKSU to ensure they are safe for consumption.

The fruit parfait, as we commonly know it today, has origins in both France and the United States. The term "parfait" is French, meaning "perfect," and it originally referred to a frozen dessert made from sugar syrup, egg, and cream, with recipes dating back to the late 19th century [2]. Auguste Escoffier, a renowned French chef, included a recipe for parfait in his 1903 culinary guide, "Le Guide Culinaire" [3]. The American version of the parfait, which often includes yogurt, fruit, and granola, began to take shape in the early 20th century, influenced by the French dessert but adapted to American tastes and ingredients [4]. The inclusion of yogurt became particularly popular in the United States during the mid-20th century, reflecting a growing interest in health and nutrition [5]. On campuses like EKSU,

fruit parfaits represent not just a meal but a lifestyle choice, fitting seamlessly into the busy schedules and health priorities of students. A typical fruit parfait is a symphony of textures and flavors, meticulously crafted with layers of goodness. The foundation is often yogurt, providing creamy base rich in protein, which promotes satiety and supports muscle health [6]. Opting for yogurt rich in live and active cultures supplies probiotics that promote balance and overall health of the gut microbiome [7]. Granola adds a delightful textural contrast and a burst of healthy fats, featuring a medley of rolled oats, nuts, and seeds that offer additional protein, healthy fats, and fiber [8]. A layer of fresh fruits tops the parfait, delivering a rich supply of vitamins, minerals, and antioxidants that are vital for supporting the immune system and protecting cells [9].

However, the safety and microbial composition of these readily available parfaits remain largely unexplored. Fresh fruits and dairy products can be prone to contamination if not handled properly. Common microbial contaminants identified in similar studies include *Escherichia coli, Staphylococcus aureus, Candida tropicalis, Enterobacter aerogenes, and Bacillus licheniformis* [10]. The detection of *E. coli* is of great concern, as it reflects fecal contamination and inadequate hygiene during preparation or handling [11]. *Staphylococcus aureus* poses a significant risk due to its ability to produce enterotoxins that lead to food poisoning, while *Candida tropicalis* contributes to product spoilage and reduces shelf life [12]. In addition, *Enterobacter aerogenes* and *Bacillus licheniformis* are opportunistic pathogens that may cause serious health issues, particularly in immunocompromised individuals [13]. Therefore, maintaining strict hygiene and appropriate storage conditions is essential to safeguard consumers and minimize the risk of foodborne infections.

Materials and Methods

Sterilization of equipment and sanitization of the workbench: All glassware were initially washed with detergent and tap water, thoroughly rinsed with distilled water, and then air-dried. They were subsequently sterilized using dry heat in a hot air oven at 160 °C for 120 minutes. Test tubes were sealed with absorbent cotton wool, wrapped in aluminum foil, and sterilized, while sampling bottles were also covered with aluminum foil after air drying and sterilized to prevent external contamination.

Sample Collection

Five randomly selected yogurt samples in plastic bottles were purchased from vendors around the Ekiti State University campus. The samples were collected in sterile sampling bottles and promptly transported to the laboratory under cold conditions of approximately 6 °C. Each batch was carried in an ice-packed container under aseptic conditions, and analysis began immediately upon arrival.

Preparation of Media used

The culture media were prepared following the manufacturer's guidelines and sterilized using moist heat in an autoclave at 121 °C for 15 minutes. The media employed in this study included Nutrient Agar (NA), Eosin Methylene Blue Agar (EMB), and Potato Dextrose Agar (PDA).

Microbiological Analysis

Microbiological examination was carried out following serial dilutions of each sample. One milliliter from the 10^{-3} and 10^{-5} dilutions was inoculated onto separate agar plates, with colonies from the 10^{-3} dilution used for determining colony-forming units (CFU). Presumptive coliform detection was performed using lactose broth incubated at 35 °C for 48 hours, after which sub culturing was done on Eosin Methylene Blue (EMB) agar and confirmed through Gram staining. Bacterial isolates were identified based on their cultural morphology and biochemical profiles, while fungal isolates were characterized by their colonial morphology and microscopic features, comparing these traits with established descriptions of recognized taxa as documented by [28].

Determination of Total Microbial Load

The total microbial load was assessed using the serial dilution method, a stepwise process that reduces a dense microbial culture to a manageable concentration. Each dilution decreases the bacterial concentration by a defined factor. Nine test tubes were labeled according to their dilution levels (10^{-1} to 10^{-9}), with each tube containing 9 ml of sterile distilled water. Under aseptic conditions, 1 ml of the sample was transferred into the tube labeled 10^{-1} and mixed thoroughly to ensure even distribution and to disperse any bacterial clumps. Subsequently, 1 ml from this dilution was aseptically transferred to the 10^{-2} tube and mixed in the same manner. This procedure was repeated sequentially through to the 10^{-9} dilution, with all steps carried out under strict aseptic techniques.

Sub-Culturing and Isolation of Distinct Colony

Plates having appropriate number of colonies was taken further enumeration. These plates were well studied to distinguish several observable distinct colonies, and each of the observable distinct colonies were sub-cultured on another plate containing about 15ml of sterile molten Nutrient Agar, Potato dextrose agar and MacConkey Agar respectively using streaking method under aseptic condition following a proper flaming of the loop. The sub-cultured plates were further incubated aerobically at 35°C for 24hours. A distinct microbial colony, preferably the one that grew separately from other colonies on the sub-cultured plates was selected, picked, and transferred into a McCartney bottle containing about 5ml of sterile slanted molten Nutrient agar following adequate flaming of the wire loop till red hot and flaming the cover, tip and opening of the bottles for sterilization.

Identification of Isolated Organisms

Once distinct colonies were isolated, their identification became necessary. Identifying isolates is a crucial step used to determine whether a microorganism belongs to an established taxonomic group and to assign its proper name. The isolates were characterized and identified based on their physiological, morphological, and biochemical properties.

Identification of Bacterial Cells from Fruit Parfait Samples: This was done by a process of biochemical characterization, where gram staining, motility test, catalase test, urease test, indole test, methyl red test, citrate utilization test, oxidase test and coagulase test.

Sugar Fermentation

The sugar fermentation test is employed to differentiate bacteria based on their ability to ferment specific carbohydrates. When a microorganism ferments a carbohydrate incorporated into the culture medium, it produces either acid alone or both acid and gas. The production of acid lowers the pH, leading to a color change in the medium due to the presence of an indicator. In this study, sugars were prepared as 1% solutions in peptone water to evaluate bacterial fermentative activity. A small inverted Durham tube was inserted into the medium to capture any gas formed, while phenol red served as the pH indicator to detect acid production. A positive acid reaction was indicated by a yellow color, confirming carbohydrate fermentation. Gas production was demonstrated by the presence of a bubble in the Durham tube. A negative result showed no color change (or a reddish color) and no bubble formation.

Isolation of Fungi

The serially diluted samples were inoculated onto Potato Dextrose Agar (PDA) plates and incubated at 28 °C for five days. Well-developed, distinct colonies were then carefully selected and further sub-cultured onto PDA slants for preservation and subsequent analysis.

Determination of Antimicrobial Activity

The disc diffusion method was used. The discs were prepared using Whatman filter paper and sterilized by hot air oven at 160^0C for 1 h. The bacteria cell was transferred from slant to a fresh nutrient agar plate and incubate at an ambient temperature for 18 h. 3-5 colonies of bacteria was transferred into 5ml of nutrient broth and incubated for 3-5 h until the turbidity is equal to that of Barium-sulphate. The bacteria cell was then swabbed using a sterile swab stick on the prepared Muller Hinton agar plate. To obtain a uniform growth of the bacterial cell, the plate was swabbed in one direction and then was rotated and the plate was swabbed in another direction. The rotation was repeated 3 times. The disc was then aseptically placed with the use of a sterilized forcep on the Muller Hinton agar plate where the bacteria cell has been placed. The plate was then allowed to incubate for 24 hours at 37 ^{0}C. After the incubation process the plates where then observed, a zone around the antibiotic disc indicates that the bacteria cell is not resistant that is the bacterial cell is susceptible to the antibiotic used. The test was done in duplicates. The zones of growth inhibition surrounding each antibiotic disc were measured to the nearest millimeter. The diameter of these zones reflects both the susceptibility of the isolate and the rate at which the drug diffuses through the agar medium. The measured zone diameters for each antibiotic were interpreted according to the guidelines provided by the Clinical and Laboratory Standards Institute (CLSI, formerly the National Committee for Clinical Laboratory Standards, NCCLS). The disk diffusion test yields qualitative results, categorizing isolates as susceptible, intermediate, or resistant, rather than providing a minimum inhibitory concentration (MIC).

Results

From Table 1, the total microbial count of isolated organism from 30 Fruit Parfait samples from 5 different brands around EKSU is shown. The lowest microbial count was observed in Tasty Delight with Total Microbial Load (Cfu/ml): 100 while the highest bacteria count was observed in Tee's pastries with Total Microbial Load (Cfu/ml): 212000).

Table 2 shows the biochemical test result of this experiment. After the biochemical test, the following organism are identified which include; *Enterobacter aerogenes*, *Candida tropicalis*, *Escherich E.coli*, *Bacillus lichenoformis*, *S. aureus*. While, other biochemical test shows varying results.

Table 3 shows the Frequency and percentage occurrence of Bacterial isolated from Fruit parfait sample from different brands around EKSU. The highest microbial occurrence was observed to be *E. coli* with the percentage of (26.67%) followed by *Enterobacter aerogenes* and *Bacillus lichenoformis* (20.00%) while the least occurrence was observed to be *S. aureus* (13.33%).

Table 4 shows the cultural, morphological and microscopy of fungi isolates in the Fruit Parfait samples from different brands around EKSU. Some of the suspected fungi isolates include *Candida sp., Botrytis sp., Saccharomyces sp., Penicillium sp., and Aspergillus sp*.

Table 5 illustrates the antimicrobial sensitivity pattern of bacteria isolated from Fruit Parfait and their percentage of resistance. Some isolates were highly resistant to Erythromycin and Ceftazidime (68.09%), followed by a resistance to Ciprofloxacin (57.47%). However, few of the isolates from Fruit Parfait were resistant to Gentamicin (6.38%).

Table 1: Total Microbial Load (CFU) of 30 fruit parfait sample obtained from 5 different vendors around EKSU

S/N	Isolate code	Dilution factor	Colonies counted	Total Microbial Load (CFU/ml)
1	K (PDA)	10^{-5}	86	8600
2	K (NA)	10^{-5}	204	20400
3	K (EMB)	10^{-5}	2	200
4	K (PDA)	10^{-3}	198	19800
5	K (NA)	10^{-3}	92	9200
6	K (EMB)	10^{-3}	3	300
7	Ta (PDA)	10^{-5}	120	12000
8	Ta (NA)	10^{-5}	65	6500
9	Ta (EMB)	10^{-5}	1	100
10	Ta (PDA)	10^{-3}	78	7800
11	Ta (NA)	10^{-3}	88	8800
12	Ta (EMB)	10^{-3}	2	200
13	Te (PDA)	10^{-5}	79	7900
14	Te (NA)	10^{-5}	124	12400
15	Te (EMB)	10^{-5}	1	100
16	Te (PDA)	10^{-3}	88	8800

17	Te (NA)	10^{-3}	212	21200
18	Te (EMB)	10^{-3}	2	200
19	S (PDA)	10^{-5}	68	6800
20	S (NA)	10^{-5}	88	8800
21	S (EMB)	10^{-5}	76	7600
22	S (NA)	10^{-3}	120	12000
23	S (EMB)	10^{-3}	2	200
24	S (PDA)	10^{-3}	97	9700
25	V (NA)	10^{-5}	58	5800
26	V (EMB)	10^{-5}	12	1200
27	V(PDA)	10^{-5}	89	8900
28	V (NA)	10^{-3}	83	8300
29	V (EMB)	10^{-3}	2	200
30	V (PDA)	10^{-5}	55	5500

KEYS: V - Vee's Parfait, S - Savory Parfait, Ta - Tasty Delight, Te - Tee's Pastries, K - Krista Treats

Table 2: Biochemical Characterization of Isolates+

S/N	Isolate	Gram RTN	Cat	Coag	Mot	Ind	Lact	Ox	MR	VP	TSIA Reaction				Urease	Organisms
											Slant	Butt	Gas	H_2S		
1	$Te10^{-3}$ (NA)	GPB	+ve	+ve	+ve	-ve	+ve	-ve	-ve	-ve					+ve	*Bacillus lichenoformis*
2	$Te10^{-3}$ (PDA)						-ve								-ve	*Candida tropicalis*
3	$Te10^{-3}$ (EMB)	GNB	+ve	-ve	+ve	+ve	-ve	-ve	+ve	-ve	Y	Y	Yes	No	-ve	*E. coli*
4	$Te10^{-5}$ (NA)	GNB	+ve		+ve	-ve	+ve	-ve	-ve	+ve					-ve	*Enterobacter aerogenes*
5	$Te10^{-5}$ (PDA)	GPB	+ve	+ve	+ve	-ve	+ve	-ve	-ve	-ve					+ve	*Bacillus lichenoformis*
6	$Te10^{-5}$ (EMB)	GNB	+ve	-ve	+ve	+ve	-ve	-ve	+ve	-ve	Y	Y	Yes	No	-ve	*E. coli*
7	$K10^{-3}$ (NA)	GPC	+ve	+ve	-ve	-ve	-ve	-ve	+ve	+ve					+ve	*S. aureus*
8	$K10^{-3}$ (PDA)	GNB	+ve		+ve	-ve	+ve	-ve	-ve	+ve					-ve	*Enterobacter aerogenes*
9	$K10^{-3}$ (EMB)	GNB	+ve	-ve	+ve	+ve	-ve	-ve	+ve	-ve	Y	Y	Yes	No	-ve	*E. coli*
10	$K10^{-5}$ (NA)	GPC	+ve	+ve	-ve	-ve	-ve	-ve	+ve	+ve					+ve	*S. aureus*
11	$K10^{-5}$ (PDA)						-ve								-ve	*Candida tropicalis*
12	$K10^{-5}$ (EMB)	GNB	+ve	-ve	+ve	+ve	-ve	-ve	+ve	-ve	Y	Y	Yes	No	-ve	*E. coli*
13	$Ta10^{-3}$ (NA)	GNB	+ve		+ve	-ve	+ve	-ve	-ve	+ve					-ve	*Enterobacter aerogenes*
14	$Ta10^{-3}$ (PDA)	GPB	+ve	+ve	+ve	-ve	+ve	-ve	-ve	-ve					+ve	*Bacillus lichenoformis*
15	$Ta10^{-3}$ (EMB)	GNB	+ve	-ve	+ve	+ve	-ve	-ve	+ve	-ve	Y	Y	Yes	No	-ve	*E. coli*
16	$Ta10^{-5}$ (NA)	GPB	+ve	+ve	+ve	-ve	+ve	-ve	-ve	-ve					+ve	*Bacillus lichenoformis*
17	$Ta10^{-5}$ (PDA)						-ve								-ve	*Candida tropicalis*
18	$Ta10^{-5}$ (EMB)	GNB	+ve	-ve	+ve	+ve	-ve	-ve	+ve	-ve	Y	Y	Yes	No	-ve	*E. coli*
19	$S10^{-3}$ (NA)	GNB	+ve		+ve	-ve	+ve	-ve	-ve	+ve	Y	Y	Yes	No	-ve	*Enterobacter aerogenes*
20	$S10^{-3}$ (PDA)						-ve								-ve	*Candida tropicalis*
21	$S10^{-3}$ (EMB)	GNB	+ve	-ve	+ve	+ve	-ve	-ve	+ve	-ve	Y	Y	Yes	No	-ve	*E. coli*
22	$S10^{-5}$ (NA)	GPB	+ve	+ve	+ve	-ve	+ve	-ve	-ve	-ve					+ve	*Bacillus lichenoformis*
23	$S10^{-5}$ (PDA)						-ve								-ve	*Candida tropicalis*
24	$S10^{-5}$ (EMB)	GPC	+ve	+ve	-ve	-ve	-ve	-ve	+ve	+ve					+ve	*S. aureus*
25	$V10^{-3}$ (NA)	GPB	+ve	+ve	+ve	-ve	+ve	-ve	-ve	-ve					+ve	*Bacillus lichenoformis*
26	$V10^{-3}$ (PDA)	GNB	+ve		+ve	-ve	+ve	-ve	-ve	+ve					-ve	*Enterobacter aerogenes*
27	$V10^{-3}$ (EMB)	GPC	+ve	+ve	-ve	-ve	-ve	-ve	+ve	+ve					+ve	*S. aureus*
28	$V10^{-5}$ (NA)	GNB	+ve		+ve	-ve	+ve	-ve	-ve	+ve					-ve	*Enterobacter aerogenes*
29	$V10^{-5}$ (PDA)						-ve								-ve	*Candida tropicalis*
30	$V10^{-5}$ (EMB)	GNB	+ve	-ve	+ve	+ve	-ve	-ve	+ve	-ve	Y	Y	Yes	No	-ve	*E. coli*

$K10^{-3}$ (NA) and $K10^{-3}$ (PDA) are both Novobiocin Sensitive, $Te10^{-3}$ (PDA), $K10^{-5}$ (PDA), $Ta10^{-5}$ (PDA), $S10^{-3}$ (PDA), $S10^{-5}$ (PDA), $V10^{-5}$ (PDA) Growth @ 50 ºC = +ve, Growth in 7% NaCl = +ve, Glucose = +ve, GNB - Gram Negative Bacteria, GPB - Gram Positive Bacteria, GPC - Gram Positive Cocci, Cat - Catlase, Cog - Coagulase, Mot - Motility, Ind - Indole, Lact - Lactase, Ox - Oxidase, MR - Methyl red, VP- Voges-Proskauer

Table 3: Frequency and percentage occurrence of isolated organisms from fruit parfait.

Microorganism	Frequency	Percentage
Enterobacter aerogenes	6	20.00%
S. aureus	4	13.33%
Candida tropicalis	6	20.00%
E. coli	8	26.67%
Bacillus lichenoformis	6	20.00%
Total	30	100

Table 4: Morphology and Cultural characteristics of suspected fungal isolates

Suspected Fungi	Cultural Characteristics	Microscopy	Morphology
Candida sp.	Cream to white colonies, sometimes slightly wrinkled	Oval to round yeast cells, pseudohyphae	Pseudohyphae, budding yeast cells
Botrytis sp.	Grayish-brown, cottony texture	Branched conidiophores, septate hyphae	Conidia in clusters
Saccharomyces sp.	Moist, smooth, creamy colonies	Round to oval cells, budding reproduction	Budding yeast cells
Penicillium sp.	Yellowish-green mycelium	Smooth, branched conidiophores with brush-like conidia heads	Conidia in long chains, branched cells
Aspergillus sp.	Greenish-yellow color with a white edge, floccose texture, velvety cream to yellow on the reverse	Septate hyphae, globose conidia, rough conidiophores	Conidia in chains, columnar head

Table 5: Antimicrobial Susceptibility Patterns of Organisms

	Organism	AUG	ERY	AMK	GEN	CFZ	CIP	COT	VAN
1	*Bacillus lichenoformis*	S	R	S	S	S	I	S	S
2	*Candida tropicalis*	R	R	R	S	R	S	R	R
3	*E.coli*	S	R	I	S	R	R	S	S
4	*Enterobacter aerogenes*	S	R	S	S	R	S	S	S
	Organism	**AUG**	**ERY**	**AMK**	**GEN**	**CFZ**	**CIP**	**COT**	**VAN**
5	*Bacillus lichenoformis*	S	R	I	S	R	R	S	S
6	*E.coli*	R	R	R	S	R	S	R	R
7	*Staphylococcus aureus*	R	I	R	I	S	R	S	R
8	*Enterobacter aerogenes*	I	R	R	S	R	S	I	I
9	*E.coli*	S	R	I	S	R	R	S	S
10	*Staphylococcus aureus*	I	R	R	S	S	R	R	I
11	*Candida tropicalis*	R	I	S	I	R	S	R	R
12	*E.coli*	I	R	I	S	R	I	R	I
13	*Enterobacter aerogenes*	I	R	R	S	R	S	I	I
14	*Bacillus lichenoformis*	S	R	R	I	R	I	S	S
15	*E.coli*	R	R	R	S	R	S	R	R
16	*Bacillus lichenoformis*	S	R	S	S	S	R	I	S
17	*Candida tropicalis*	S	S	S	I	R	R	R	S
18	*E.coli*	S	R	I	S	R	R	S	S
19	*Enterobacter aerogenes*	S	S	S	I	R	R	R	S
20	*Candida tropicalis*	R	I	R	I	R	R	S	R
	Organism	**AUG**	**ERY**	**AMK**	**GEN**	**CFZ**	**CIP**	**COT**	**VAN**
21	*E.coli*	I	R	I	S	R	I	R	I
22	*Bacillus lichenoformis*	R	I	R	I	R	R	S	R
23	*Candida tropicalis*	I	R	S	S	S	R	I	I
24	*Staphylococcus aureus*	R	I	S	I	R	S	R	R
25	*Bacillus lichenoformis*	S	R	I	S	R	R	S	S
26	*Enterobacter aerogenes*	S	S	S	I	R	R	R	S
27	*Staphylococcus aureus*	I	R	R	S	S	R	R	I
28	*Enterobacter aerogenes*	S	R	R	I	R	I	S	S
29	*Candida tropicalis*	S	R	S	S	S	R	I	S
30	*E.coli*	R	R	R	S	R	S	R	R

Total Percentages

- AUG: 40% Susceptible, 60% Resistant
- ERY: 13.33% Susceptible, 53.33% Resistant, 33.33% Intermediate
- AMK: 46.67% Susceptible, 40% Resistant, 13.33% Intermediate
- GEN: 73.33% Susceptible, 13.33% Resistant, 13.33% Intermediate
- CFZ: 40% Susceptible, 60% Resistant
- CIP: 46.67% Susceptible, 53.33% Resistant
- COT: 40% Susceptible, 46.67% Resistant, 13.33% Intermediate
- VAN: 53.33% Susceptible, 33.33% Resistant, 13.33% Intermediate
- Key: CIP =Ciprofloxaxin, VAN =Vancomycin, AMK= Amikacin, GEN =Gentamicin, CFZ=Ceftazidime, AUG= Augmentin, COT= Cotrimoxazole, ERY=Erythromycin, R-Resistance, S-Susceptible, I-Intermedi

Discussion

Fruit parfaits have become a popular food choice on campus, appreciated for their convenience, perceived health benefits, and visually appealing presentation [1]. Their convenience and perceived health benefits have made them a popular choice for consumers seeking a quick and healthy snack [14]. However, concerns regarding the potential presence of pathogenic organisms and the overall nutritional content of these products have also emerged [15, 16]. This project addressed these concerns by employing rigorous microbiological analyses of RTE fruit parfaits sold around EKSU, examining the presence of harmful microorganisms to provide a comprehensive understanding of their safety and health impact. The analysis of the microbiological

profile of the fruit parfait samples revealed a diverse range of microorganisms [17]. *Enterobacter aerogenes* was found in 20.00% of the samples, indicating possible contamination from raw ingredients or improper handling during preparation [18]. While generally considered a low-risk pathogen, it can cause opportunistic infections in immunocompromised individuals [19]. *S. aureus*, present in 13.33% of the samples, is a well-known foodborne pathogen notorious for causing food poisoning through enterotoxins [20]. Even small quantities can pose a significant health risk [21]. Antibiotic resistance testing revealed that some isolates were highly resistant to Erythromycin and Cefazolin (60%), followed by resistance to Ciprofloxacin (53.33%). However, only a few isolates from the fruit parfaits were resistant to Gentamicin (13.33%). The combined presence of pathogenic bacteria like *S. aureus* and *E. coli*, along with spoilage organisms such as *Candida tropicalis* and *Bacillus lichenoformis*, raises significant concerns about the safety and quality of the fruit parfaits. These findings emphasize the need for stringent hygiene practices throughout the production process, from ingredient handling and preparation to storage and distribution, to ensure the product's safety for consumption [26]. Regular microbiological testing is crucial to monitor and control contamination levels, minimizing the presence of harmful bacteria and preventing foodborne illnesses [27].

Conclusion

This project contributes to a better understanding of the health benefits and potential risks associated with RTE fruit parfaits. The study on the microbial analysis of fruit parfaits sold around Ekiti State University revealed critical insights into the microbiological safety of these popular food items. Based on the analysis of the microbiological profile of the tested RTE fruit parfaits, it is evident that the presence of pathogenic organisms such as *S. aureus* and *E. coli*, along with spoilage organisms like *Candida tropicalis* and *Bacillus lichenoformis*, raises significant safety concerns. These findings underscore the critical need for stringent hygiene practices throughout the entire production process, from raw ingredient sourcing to preparation, handling, and storage. Manufacturers, on the other hand, have a critical role in ensuring the safety and quality of their products. The findings call for an enhancement of current hygiene protocols and regular microbiological testing to monitor and control contamination levels. Manufacturers should invest in staff training focused on best practices in food safety and hygiene to mitigate the risks of pathogenic contamination. Additionally, fungal contamination can lead to spoilage and the production of mycotoxins, which have serious health implications. Proper storage conditions to prevent fungal growth, emphasizing the importance of maintaining low humidity and appropriate temperatures, are essential. The study highlights the urgent need for improved food safety measures for fruit parfaits sold around Ekiti State University. The presence of pathogenic microorganisms and high microbial loads in several samples underscores the health risks posed by these products. By implementing enhanced hygiene practices, providing ongoing education and training to food handlers, and ensuring regular monitoring and inspection, the safety of fruit parfaits can be significantly improved. Ultimately, a collaborative effort between food vendors, regulatory authorities, and consumers is crucial to safeguarding public health and ensuring the microbiological quality of food products sold in the region.

In conclusion, this project underscores both the popularity and potential risks of RTE fruit parfaits. The detection of pathogenic organisms in these products highlights the need for stringent hygiene practices and regular monitoring. Consumers should prioritize purchasing from reputable brands and adhere to proper storage practices. Manufacturers must enhance hygiene protocols and invest in regular microbiological testing and staff training. Continued research and vigilance are necessary to ensure the safety and quality of fruit parfaits, benefiting both consumers and the broader food industry.

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