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Research Article

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Evaluation of Microbial Quality of Food Served in School Cafeterias in Hodeidah City- Yemen

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Abstract: This study was conducted to assess the microbial quality of food served in school cafeterias in Hodeidah city-Yemen. Fifteen samples were randomly collected and transported to the laboratory for microbiological analysis, including total bacterial count, coliform bacteria, *E. coli*, yeast, molds, *Staphylococcus aureus*, and *Salmonella*.

The results showed that only two samples (S1 & S6) were free from any microbial contamination. The total bacterial count was elevated in (86.6%) of the samples studied, while (53.3%) were contaminated with coliform bacteria. *E. coli* was present in (33.3%) of the samples, while (60%) were contaminated with yeast and (66.6%) with mold. *Staphylococcus aureus* was detected in (33.3%) of the samples, and *Salmonella* was present in (20%) of the samples. These results indicate high microbial contamination of the food served in schools in Hodeidah, posing a health risk to students. Therefore, cafeteria staff must adhere to health regulations when preparing food for students and implement a continuous monitoring program.

Keywords: Microbial Quality of Food, Yemen, food service in school cafeterias, microbial count of food, microbiological analysis

1. Introduction

Due to changes in lifestyle and the need for people to eat outside the home for work or study reasons, food service establishments, including cafeterias in schools and universities, have increased in recent years (Soares et al., 2020). Therefore, the importance of the safety of the food provided in these places has emerged due to its direct link to public health. Many countries have enacted strict legislation for food preparation and service places, especially in schools and universities, to preserve the health of students and protect them from diseases and food poisoning incidents (WHO, 2000).

Many researchers have pointed out cases of food poisoning among school students due to consuming contaminated food (Esena and owusu, 2013 & Melody and Eric, 2020). Also, several studies have revealed an increase in the total microbial count of food served in schools, posing a real risk to this group (Giampaoli et al., 2002). Therefore, legislation and laws have sought to enforce strict health regulations on Cafeterias and food service establishments in schools were mandated to undergo periodic inspections to ensure proper food preparation and minimize contamination. Emphasis was placed on educating and training staff on food safety issues, conducting regular health examinations to ensure they were free from infectious diseases.

The aim of the research was to evaluate the microbial quality of food served in school cafeterias in Hodeidah city.

2. Materials and Methods

Sample Collection: Fifteen food samples were randomly collected from 15 schools in Hodeidah city, including various types of food (beans, potatoes, eggs, chips, falafel, mixed). The samples were purchased routinely and placed in sanitized plastic bags, then stored in a cooler and transported to the laboratory for necessary microbiological analyses.

Sample Preparation: Ten grams of each sample were weighed and mixed with 90 mL of sterilized peptone salt solution. The mixture was blended using a Lab Blender (India) for 60 seconds. Serial dilutions were prepared using 9 mL of sterilized peptone salt solution, and 1 mL from each sample was transferred to the dilution series using the serial dilution method. An aliquot from each dilution was plated onto petri dishes for microbial culture (APHA,1998).

Microbial Culture: For *Salmonella spp*. (Xylose Lysine Deoxycholate Agar, XLD agar) was used and incubated at 37°C for 24-48 hours (ISO 6579:2002). For *Staphylococcus aureus*, (Baird-Parker agar) was used and incubated at 37°C for 48 hours (ISO 6888-2:1999&ISO 6888-1:1999). Total count of bacterial (TCB) was determined using (Plate Count Agar) at 30°C for 72 hours (ISO 4833:2003). Yeasts and molds were cultured on (Sabouraud Dextrose Agar) at 30°C for 3-5 days (ISO 13681:1995). Escherichia coli was cultured on (Tryptone-Bile-Glucuronic Medium) (TBX) at 42°C for 24 hours (ISO 16649-2:2001). For Total Coliform bacteria, (McConkey agar) was used and incubated at 37°C for 24 hours (NP: 3780:1990).

3. Results and Discussion

Total Count of Bacterial

The results in Table 1 showed an increase in total bacterial counts in (86.6%) of the samples under study, ranging between 3 x 10^3 and 6.2 x 10^5 cfu/g, while samples S1 and S6 were free from any microbial contamination. Similar results were found by Trindade et al. (2014), where (81.1%) of school food samples had high total bacterial counts, which indicate poor quality. Melody and Eric (2020) reported that (41.7%) of the samples of food served in schools had high total bacterial content. The findings were consistent with Gupta et al. (2011), who found high microbial counts in ready-to-eat food samples taken from school cafeterias. The high total bacterial count in ready-to-eat foods indicates poor preparation practices and unsanitary conditions. During sample collection, most ready-to-eat foods were observed to be uncovered, exposing them to airborne contamination.

Total Coliform Bacteria

The results in Table 1 showed that (53.3%) of the samples were contaminated with coliform bacteria, with counts ranging between 103 and 1.3 x 103 cfu/g. The study findings were consistent with Dalee et al. (2017), who found contamination of school food samples with Total Coliform bacteria, indicating initial indicators of contamination and lack of adherence to hygiene conditions during food preparation. They also agreed with Trindade et al. (2014), who reported that (52.9%) of school food samples were contaminated with coliform bacteria. Coliform bacteria are predominantly found in the intestines, so their presence in food indicates contamination with human or animal fecal matter (Jay 2000).

E. coli bacteria

The microbial analysis results in Table 1 indicated that 33.3% of the samples were contaminated with *E. coli* bacteria. This percentage was lower than what Goburdhun et al. (2019) found, where 67% of school foods were contaminated with *E. coli*. However, the results were similar to those of Bankole et al. (2012), who found contamination in 35% of school food samples with this type of bacteria. *E. coli* bacteria can be transmitted through workers' hands, indicating a lack of adherence to hygiene conditions during food preparation, which require handwashing with soap and water before handling or preparing food (Mirabaud et al., 2003). Saraiva et al. (2018) also indicated that the primary source of *E. coli* bacteria is human feces, and their presence in food indicates poor hygiene and lack of sanitary conditions. Several studies have linked the presence of *E. coli* bacteria in food to cases of food poisoning among school's students (Kaferstein, 2003; Okolie et al., 2012; Oranusi et al., 2007).

Yeasts

The results in Table 1 showed that (60%) of the samples were contaminated with yeasts, with counts ranging between 10 and 3 x 102 cfu/g, with sample S15 being the most contaminated with yeasts. Similar results were

found by Giwa et al. (2021), who reported contamination in 37.50% of samples with yeasts. The presence of yeasts in food indicates incidental contamination, especially with starchy foods, and the presence of yeasts in food leads to undesirable fermentations, resulting in unpleasant taste and odor in food (Adams and Moss, 2008).

Molds

The study results (Table 1) indicated that (66.6%) of schools food samples were contaminated with mold. This percentage was higher than what Soares et al. (2020) found, which indicated that contamination of schools and university food was due to prolonged exposure to air and lack of hygiene conditions in food preparation areas. Many molds produce fungal toxins during their growth on food (Abyaneh, 2014), which several studies have shown to have serious negative effects on human health (Maia et al., 2014; Aycan and Elif, 2019).

Staphylococcus aurus

The microbial analysis results of the samples (Table 1) indicated that (33.3%) of the samples were contaminated with *Staphylococcus aureus* bacteria. These results were lower than those found by Trindade et al. (2014), who reported that (73.3%) of food samples prepared in schools were contaminated with *Staphylococcus aureus*. However, the results were similar to those found by Goburdhun et al. (2019) and Gupta et al. (2011), who found contamination rates of (30.5%) and (28.1%), respectively, of school foods with *Staphylococcus aureus*. *Staphylococcus aureus* bacteria are found on human and animal skin and in soil, and they can be transferred to food through incidental contamination from one of these sources, especially food handlers, making it one of the most important causes of foodborne diseases worldwide (Wu et al., 2018). The bacteria produce a wide range of heat-resistant enterotoxins that cause food poisoning in humans (Sugrue et al., 2019). Several studies have indicated that contamination of ready-to-eat foods with *Staphylococcus aureus* bacteria has led to cases of food poisoning (Huong et al., 2010; Xiaohong et al., 2015; Hennekinne, 2018).

Salmonella spp

The microbial analysis results of the schools food samples indicated that (20%) of the samples were contaminated with *Salmonella* bacteria. The study results were consistent with those found by Motladiile et al. (2019), who found contamination of schools food samples with *Salmonella*. However, the results were lower than those found by Giwa et al. (2021), who reported that (10.7%) of the samples were contaminated with *Salmonella*. The study results differed from those of Soares et al. (2020) and Adzhani et al. (2018), who found that school's cafeteria foods were free from *Salmonella*. *Salmonella* is present in the human intestine (CDC, 2013), and it can be transmitted to food either directly or through incidental contamination of food (Nurlaela, 2011). Contamination with *Salmonella* bacteria leads to cases of food poisoning (Khan et al., 2015).

Most of the food-related diseases in schools are attributed to a lack of knowledge about food safety issues and improper practices of food handlers in school cafeterias, in addition to negligence in the stages of food preparation, storage, and serving (Melody and Eric, 2020). Furthermore, poor hygiene of the premises, utensils, and equipment in food vending areas and the presence of animals are all factors that contribute to microbial contamination of food served to students (Oranusi et al., 2007). Similar studies have indicated that improper handwashing is a major factor in the transmission of pathogens, including those responsible for foodborne illnesses (Akinsola et al., 2017) The inadequacy (Hertzman & Barrash, 2007) of not having head coverings during meal preparation ((Giampaoli et al, 2002), placing food in the temperature danger zone (5-60°C) for several hours (Henroid & Sneed, 2004), insufficient reheating of food (Kim & Shanklin, 1999), failure to clean and sanitize equipment, and eating in food preparation areas (Giampaoli et al, 2002), in addition to air pollution (Trindade et al, 2014), are all factors contributing to food contamination in schools.

Table 1: Microbiological counts (expressed as log CFU/g) of food school under study.

Samples	TCB	TC	*E. coli*	Y	M	*S. aurus*	*SAL*
S1	-	-	-	-	-	-	-
S2	$4X10^5$	10^2	-	-	-	+	-
S3	$1.3X10^5$	$2X10^2$	+	-	-	+	-
S4	$1.7X10^4$	$5X10^2$	+	10	-	+	-
S5	$2.2X10^5$	$5X10^2$	+	10^2	$5X10^4$	-	-
S6	-	-	-	-	-	-	-
S7	$1.8X10^5$	-	-	10^2	$1.1X10^2$	+	+

S8	$1.5X10^5$	-	-	10^3	$2.9X10^2$	-	-
S9	$1.4X10^4$	10^2	-	10^2	$2X10^2$	-	-
S10	$2.3X10^5$	$8X10^2$	-	10^2	$5X10^3$	-	-
S11	$3.1X10^4$	-	-	10	$4.2X10^2$	-	-
S12	$3.3\ X10^4$	-	-	-	10^2	-	-
S13	$3X10^3$	-	-	-	10^2	-	-
S14	$4X10^5$	$1.3X10^3$	+	$2x10^2$	$4X10^2$	-	+
S15	$6.2X10^5$	$2.6X10^2$	+	$3X10^2$	$3x10^3$	+	+

TCB: Total Count Bacteria, TC: Total Coliform, Y: Yeasts, M: Molds, *S. aureus*: *Stapylococcus aurus*, *SAL*: *Salmonella*

4. Conclusion

The study results revealed that only two samples of the food provided in schools in Hodeidah city were free from microbial contamination, while the rest of the samples were microbiologically contaminated. This indicates a lack of adherence to health regulations during food preparation in schools cafeterias. It is imperative for the school health authorities to monitor the process of food preparation, handling, and serving in schools and enforce compliance with health standards during meal preparation to prevent students from contracting foodborne illnesses.

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