

Quality Of Cooked Foods In Urban Schools In Ghana: Review Of Food Borne Diseases And Health Implications

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Abstract: This study reviews microbial quality of ready-to eat foods; specifically food safety, basic Hazard Analysis and Critical Point [HACCP] and public perception of food borne diseases. Others include the vulnerable group of food borne diseases, bacterial food borne diseases, causes of food borne diseases. The objective of this study is to review the microbial quality of vended foods in urban school canteens in Ghana. This study determines the microbial levels of vended foods sold in Schools to explore food borne diseases of vended food in relation to hygienic practices and to recommend measures that can be implemented to ensure microbial food safety in School canteens in urban areas. This is a descriptive desk review of facts from the literature. Information were obtained from health records the Ghana Ministry of Health (MOH), Ghana Health Service (GHS), Ghana Statistical Service, (GSS) Food and drugs Board and literature from International Journals and from the website. All these were analyzed and described.

Keywords: Microbial Quality, Hazard Analysis and Critical Control Point (HACCP), Quality Improvement (QI), Vended foods, Food Hygiene

INTRODUCTION

Poor nutritional status render people, particularly infants and children, susceptible to food borne infections (WHO, 2002) especially food sold in urban Schools in developing countries. But there are key factors which could lead to susceptibility of Food borne infections. For example age. Those in extreme age groups have either not developed or have partially lost protection from infection (WHO, 2006). Those with weakened immune system also become infected with food borne pathogens even at lower doses which may not produce an adverse reaction in healthier persons. For example, seriously ill persons, suffering from cancer or AIDS, are more susceptible to infections with *Salmonella*, *Campylobacter*, *Listeria*, *Toxoplasma*, *Cryptosporidium*, and other food borne pathogens. It has been noted that risk factors such as age, immune status, debilitating disease, stress factors, and the physiological state of the stomach and upper small intestine at the time of exposure to the agent determines the nature of infections. For these reasons a minimum infectious dose cannot be defined, although the risk of disease at low exposure for some agents even at low exposure to some agents could lead to adverse reaction (Health Protection Agency, 2009). Most foodborne diseases are caused by microbial pathogens such as viruses, bacteria and parasites although few might be caused by physical and/or chemical contamination. Of all the pathogen types (*i.e.*, bacteria, fungi, parasites, and viruses), it has been found that over 90 percent are confirmed to cause foodborne human illness cases and deaths (Bean *et al.* 1990).

There is a wide spectrum of food and water borne infections such as cholera, campylobacteriosis, cryptosporidiosis, *E coli* infections, salmonellosis, Shigellosis, enteric fevers, brucellosis, hepatitis, amoebiasis and *trematode* infections (Cartwright, 2003). These dangerous microorganisms are widely found in soil, water, animal and people. But the main agents of foodborne and diarrhoeal diseases are enteroviruses, (e.g. rotavirus, *Escherichia coli* [Enterotoxigenic *E. coli*, Enteroinvasive *E coli* etc] *Campylobacter* sp, *Shigella*, *Vibro cholera* (01 and 0139), *Salmonella* sp, *Entamoeba histolytica*, *Giardia Lambia* and *Cryptosporidium* sp. These microorganisms may be carried on hands, wiping cloths and utensils and cutting boards; and it is important to take note of their health implications in urban Schools. These bacterial food borne diseases are presented as follows:

1.2 Statement of the problem

Food safety is a public health concern especially the foods served to students and pupils at Schools by vendors. Children in the African region usually experience five episodes of diarrhea per year and about 800,000 children die each year from diarrhea and dehydration (Mead *et al.*, 1999). Diarrhoea remains the third cause of death among children under age five, accounting for 10,000 deaths annually. Saba and Gonzalez-Zorn (1999) identified that the microbiological food contamination in Ghana is alarming. In support of this notion, Mensah *et. al.*, (2002) indicated that there have been higher levels of contamination in vended food given to children than in food cooked at home in Ghana. The estimated number of foodborne diseases reported in Ghanaian hospitals is about 420,000 per year, with an annual death rate estimated at 65,000 and a total costs to the Ghanaian economy at US \$ 69 million (WHO, 2006).

METHODS

This is a descriptive desk review study of facts from the literature. Information were obtained from health records the Ghana Ministry of Health (MOH), Ghana Health Service (GHS), Ghana Statistical Service, (GSS) Food and Drugs Authority and literature from International Journals and from website. All these were analyzed and described.

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Ethical review

Ethical approval was obtained from the Ethical Review Board of Ghana Health Service through the University of Ghana Institute of Environmental and Sanitation Studies. Approval was obtained from the Municipal Director of Health services.

BACTERIAL FOODBORNE DISEASES

Food borne disease caused by Salmonella

Salmonella species are Gram-negative, flagellated facultative anaerobic bacilli. Most of them are motile with flagella. They ferment glucose and produce acid and gas or acid only. The genus *Salmonella* is divided into two species that can cause illness in humans: *S. enterica* and *S. bongori*. Further, *Salmonella enterica*, which is of the greatest public health concern, comprise of six subspecies: *S. enterica subsp. enterica* (I) *S. enterica subsp. salamae* (II) *S. enterica subsp. arizonae* (IIIa) *S. enterica subsp. diarizonae* (IIIb) *S. enterica subsp. houtenae* (IV) and *S. enterica subsp. indica* (VI) (FDA, 2012) Adams, (1995) observed that in comparison with the rest of the gram-negative rods, *Salmonella* is resistant to various environmental factors, thrive at temperatures ranging from 8°C and 45°C and in a pH range of 4 to 8. Infection results from the ingestion of food or water containing sufficient number of these bacteria to reach and invade the small intestine (Adams, 1995) *Salmonella* is usually harmful to humans and animals. Hopkins (2000) noted that salmonella has been implicated in France as having involved in 75.6 percent of reported foodborne outbreaks. *Salmonella* induces three main types of illnesses in humans. These include Enteric fever (Typhoid fever), Bacteremia and Enterocolitis, but mixed forms are frequent (Jawetz, Melnick, and Adelberg's, 2004). According to Blaser (2004) many of the infections of salmonella are endemic due to inappropriate handling of contaminated food in kitchens, improper storage, undercooking and cross contamination According to (FDA 2012), *Salmonella* causes two kinds of disease depending on the serotype [nontyphoidal salmonellosis] and typhoid fever. Clark, 2002 identified that salmonella causes typhoid and other diseases of intestinal origin. The presence of salmonella in ready-to-eat foods may be a result of undercooking, poor handling practices and cross contamination.

Nontyphoidal salmonellosis

This is caused by serotypes other than *S. Typhi* and *S. Paratyphi A*. Mortality is generally less than 1% and the onset of the disease is 6 to 72 hours after exposure. It has infective dose as low as one cell, depending on age and health of host. FDA/CFSAN, 2003b. It has been noted that as few as 15 cells can cause illness. The Symptoms include nausea, vomiting, abdominal cramps, diarrhea, fever, headache. The symptoms may last from 4-7 days. Its complications include dehydration leading to death in the very young, the elderly, and the immunocompromised. Dehydration and electrolyte imbalance may occur as a result of diarrhea and vomiting. This can lead to death in the very young, the elderly, and the immunocompromised. It might also lead to reactive arthritis (example, joint inflammation, urethritis, uveitis, and/or conjunctivitis). Blood and internal organ poisoning might also result if not treated promptly. The major route of entry is contaminated food and water.

Typhoid Fever

This is caused by serotypes *S. Typhi* and *S. Paratyphi A*, both of which are found only in humans. The onset after exposure ranges from 1 week to 2 months with a mortality as high as 10 % and infective dose fewer than 1,000 cells. Symptoms include high fever, abdominal pains and diarrhea or constipation; headache; achiness; loss of appetite. Notable among the complications include chronic infection of the gallbladder causing the infected person to become a carrier. Septic arthritis may occur, in which the infection directly affects the joints and may be difficult to treat. The major route of infection is contaminated food and water (Parker, 1984). According to (WHO, 2004) indicated that Typhoid fever is still common in the developing world, where it affects about 12.5 million persons each year,

Associated foods

There are three main ways *Salmonella* can enter the food supply to cause illness. Firstly, animals harbor *Salmonella*, making meats, poultry, eggs, and milk often implicated vehicles. *Salmonella*, which are introduced into the environment, possibly through manure and litter, may persist and contaminate fruits and vegetables on the farm. Cross-contamination in the food service environment or the home, often between raw poultry and ready-to-eat products, such as raw vegetables, can also cause salmonellosis. Man introduces salmonellosis through improper food handling practices and perpetuates salmonellosis through recontamination of rendered animal by-products, which are incorporated into livestock feeds. The organism survives on low-moisture foods, such as spices, which have been the vehicles for large outbreaks. Some examples of foods that have been linked to *Salmonella* illness include meats, poultry, eggs, milk and dairy products, fish, shrimp, spices, yeast, coconut, sauces, freshly prepared salad dressings made with unpasteurized eggs, cake mixes, cream-filled desserts and toppings that contain raw egg, dried gelatin, peanut butter, cocoa, produce (fruits and vegetables, such as tomatoes, peppers, and cantaloupes), and chocolate (FDA, 2012) Generally, the source of contamination can be traced to a carrier whose personal hygiene is poor (Bryan, 1979). *Salmonella* can frequently be isolated from raw foods of animal origin. Environmental contamination can also result in *Salmonella* being present in a wide variety of foods, although generally at lower numbers. Their presence in ready-to-eat foods may be a result of undercooking, poor handling practices and cross contamination. *Salmonella* can occasionally be isolated from fresh fruit and vegetables, and these may be a source of contamination when included in ready-to-eat food.

Shigella infection

Shigellae are Gram-negative, non-motile, non-spore forming, rod-shaped bacteria. *Shigella* species, which include *Shigella sonnei*, *S. boydii*, *S. flexneri*, and *S. dysenteriae*, are highly infectious agents. Some strains produce enterotoxins and Shiga toxin (FDA, 2012). *Shigella* causes the disease Shigellosis, or bacillary dysentery. The disease, is caused by bacteria of the genus *Shigella*, which include *S. dysenteriae*, *S. flexneri*, *S. boydii*, and *S. sonnei* (Bryan, 1979). It lives in the intestinal tract of humans. In line with this fact, Bryan (1978) identified that *Shigella* may persist in the intestinal tract of humans for months. Their major transmission mode is person-to-person through the fecal-oral route. Feldman and

Riley, 1985), noted that there have been some documented cases of foodborne shigellosis and some strains are associated with mortality rates as high as 10-15% and infective as low as 10 to 200 cells, depending on the age and condition of the host FDA (2012). Erwert et al., (2003) observed that Shiga toxins block mRNA transcription and induce apoptosis in endothelial cells. Severe cases, which tend to occur primarily in immunocompromised or elderly people and young children, are associated with mucosal ulceration, rectal bleeding, and potentially drastic dehydration (FDA/CFSAN, 2003). Keusch et al., (1985) indicated that enterotoxins, (Shiga toxins), may be produced by *S. dysenteriae* and possibly by *S. flexneri* type 2A. Symptoms of the disease may include abdominal pain; cramps; diarrhea; fever; vomiting; blood, pus, or mucus in stools and tenesmus (straining during bowel movements).

Associated foods

Foods usually associated with the diseases include Salads (potato, tuna, chicken, and macaroni), raw vegetables, bakery products (e.g., cream-filled pastries), sandwich fillings milk and dairy products and poultry. Most cases of shigellosis are caused by ingestion of fecally contaminated food or water. In the case of food, the major factor for contamination often is poor personal hygiene among food handlers. From infected carriers, this pathogen can spread by several routes, including food, fingers, feces, and flies, Salads (potato, tuna, chicken, and macaroni). The major foods involved in outbreaks include a variety of salads and seafoods (Morris, 1986) contaminated during handling by infected workers (Bryan, 1978). Naimi et al., (2003) reported that about six outbreaks in the United States and Canada in 1998 involving *S. sonnei* were traced back to parsley grown in Mexico. Improper refrigeration of the contaminated product often contributes to illness. In this connection Smith, (1987) indicated that food microbiologists should expect that *Shigella* species cause a rather severe form of foodborne illness even in their relatively low numbers.

Clostridium Perfringens infections

According to FDA (2012), *Clostridium perfringens* is anaerobic (but aerotolerant), Gram-positive, spore-forming rod that produces enterotoxins as well as gas when growing. Strains of the microorganism are divided into five toxin types, A to E, based on the production of four lethal extracellular toxins (alpha, beta, epsilon, and iota) (IFT, 2004). *C. perfringens* has been closely associated with gas gangrene. Jawetz et. al. (2004) observed that some strains produce enterotoxins which cause food poisoning. Spores of the organism persist in soil, sediments, and areas subject to human or animal fecal pollution. Hontonyon (2006) intimated that the microorganisms and their endospore had been isolated in many foods including red-meats, poultry, seafood and vegetable coated with soil or dust. FDA (2012) noted that foodborne disease caused by the organism takes two forms; the *gastroenteritis form and enteritis necroticans* or "pig-bel disease" The infective dose that causes symptoms is large numbers ($> 10^6$) vegetative cells or $>10^6$ spores/g of food. Common symptoms associated with the disease include watery diarrhea and mild abdominal cramps. Onset of the disease due to *C. perfringens* usually occurs 8–22 hr after ingestion of food containing large numbers. The milder form of the disease generally lasts 12 to 24 hours. In the elderly or infants, symptoms may last 1 to 2 weeks. The route of entry into the

host is through the mouth. Mead et al., (1999) are of the view that due to underreporting, estimates of the number of annual cases range from 10,000 to 250,000 in the United States alone.

Foods associated with

The actual cause of poisoning by this organism is temperature abuse of cooked foods. Meat, poultry and their products (gravies etc) are the most common *C. perfringens* vehicles (IFT, 2004).

E. coli infection

Currently, there are six recognized pathogenic groups among which four are known to be transmitted through contaminated food and water. The four are enterotoxigenic *E. coli* (ETEC), enteropathogenic *E. coli* (EPEC), enterohemorrhagic *E. coli* (EHEC) and enteroinvasive *E. coli* (EIEC). In general *E. coli* is a Gram-negative rod-shaped bacterium. They are characterized by the production of Shiga toxins, enterotoxins and other disease causing substances. They cause diseases ranging from traveler's illness, infantile diarrhea to bacillary dysentery. They have fatality rate of range of 3 % to 50 % and an infective dose range as low as 10 cells to as high as 10 billion cells. The onset of the disease ranges from about 4 hours to nine days. Among the four pathenogenic group, the common symptoms include bloodless diarrhea to entirely bloody diarrhea, fever, vomiting, abdominal pains, malaise and dysentery. The route of entry ranges from purely oral (e.g., ingestion of contaminated food, water, or fecal particles) to person-to-person. *Escherichia coli* can survive for varying periods on the fingers and other parts of the body (Pether & Gilbert, 1971). According to NSW/FA (2009), *E. coli* is part of the normal microflora of the intestinal tract of humans and warm-blooded animals. Their presence in ready-to-eat foods (fully cooked or those containing raw fruits or vegetables) is thus an indication of poor hygiene and sanitation or inadequate heat treatment.

Associated foods

The foods associated with the four groups of foodborne *E. coli* infection are similar with some little difference. For instance FDA (2012) noted that infected humans are the only known reservoirs of EIEC and for that matter any food contaminated with human feces from an ill individual, either directly or via contaminated water, can be infectious. On the other hand raw or undercooked ground beef and beef products are the vehicles most often implicated in O157:H7 outbreaks (FDA, 2012) *E. coli* O157:H7 was recovered from 2.8% samples of minced beef and beef burgers from butcher shops and supermarkets in the Republic of Ireland. Fresh packaged burgers from supermarkets had the highest prevalence of 4.5%, while fresh unpackaged mince had the lowest prevalence of 2 % (Cagney et al, 2004). Other foods implicated in O157:7 outbreaks include yogurt, mayonnaise, fermented sausages, cheeses, and unpasteurized fruit juices. Foods implicated in past EPEC outbreaks have included raw beef and chicken, but any food exposed to fecal contamination is strongly suspect. Further, most ETEC outbreaks are linked to consumption of contaminated food or water. ETEC is often found in feces of asymptomatic carriers, and humans appear to be the most likely source of ETEC (FDA, 2012)

Bacillus aureus infection

It is a Gram-positive, facultative anaerobic, endospore-forming rod. *B. cereus* occurs widely in the environment and usually isolated from soil and vegetation. It has an optimal growth temperature of 28°C to 35°C, with a minimum growth temperature of 4°C and a maximum of 48°C. Growth occurs in pH ranges from 4.9 to 9.3, and the organism tolerates 7.5% salt concentration. Mead et al., (1999) observed that an estimated 27,000 cases of foodborne illness due to *B. cereus* occur annually in the United States. Two types of illness are caused by two distinct metabolites (toxins):

- i. The diarrheal type of illness is caused by a large-molecular-weight protein. Onset of this type is 6 to 15 hours after consumption of contaminated food.
- ii. The vomiting (emetic) type of illness is associated with cereulide, an ionophoric low-molecular-weight dodecadeptide that is pH-stable and heat- and protease-resistant. The onset of Emetic type is 0.5 to 6 hours after consumption of contaminated foods.

In this connection, Granum (1997) asserted that a large molecular weight protein causes the diarrheal response, whereas cereulide, a small peptide stable for 20 min at 121°C, causes the emetic response. According to IFC (2004), symptoms of the diarrheal syndrome include diarrhea, abdominal cramps, and tenesmus, whereas nausea and vomiting are the principal symptoms of the emetic syndrome. The number of organisms that often causes human illness is 10^6 to 10^8 . Notable among the complications likely to occur in severe cases include severe systemic and pyogenic infections, gangrene, septic meningitis, cellulitis, panophthalmitis, lung abscesses, infant death, and endocarditis (FDA, 2012).

Associated foods

The varieties of foods, associated with both the diarrheal-type food poisoning and the vomiting-type include: meats, milk, vegetables, fish, , starchy foods, (macaroni potato, pasta, rice products, dishes that contain corn and corn starch), cheese products and food mixtures (sauces, puddings, soups, casseroles, pastries, and salads) (BBB), Johnson, (1984). FDA/CFSAN, (2003) quoted in IFT (2004) observed that chicken fried rice was implicated in a 1993 outbreak in Virginia that affected 14 people.

Staphylococcus aureus infection

Staphylococcal species are Gram-positive, non-motile, catalase-positive, small, spherical bacteria (cocci), which, on microscopic examination, appear in pairs, short chains, or bunched in grape-like clusters. Staphylococci are ubiquitous and impossible to eradicate from the environment. Many of the 32 species and subspecies in the genus *Staphylococcus* are potentially found in foods due to environmental, human, and animal contamination" (FDA, 2012). The FDA (2012) further observes that *Staphylococcus aureus* is found in foods and can make toxins (enterotoxins) that might not be destroyed by cooking, although the bacterium itself can be destroyed by heat. Several different protein enterotoxins exist some of which include Staphylococcal Enterotoxins A, B, C1, C2, C3, D, E, G, H, I, and (Tatini et al., 1984, Balaban and Rasooly, 2000). In this connection, Mead et al., (1999) indicated that staphylococcal food intoxication is estimated to cause 185,000

cases of foodborne illness annually Staphylococci are mesophilic and grow in temperature ranges of 7°C to 47.8°C, with 35°C being the optimum temperature for growth. The growth pH range is between 4.5 and 9.3, with an optimum between 7.0 and 7.5. The staphylococcal enterotoxins have an infective dose of less than 1.0 microgram representing about 100,000 organisms /g in food. Bergdoll (1979) identified that the onset of staphylococcal foodborne illness may occur between 30 min and 8 hr following consumption of the toxin-contaminated food. The route of entry is consumption of food contaminated with enterotoxigenic *S. aureus* or ingestion of the enterotoxin. Common symptoms of staphylococcal intoxication include nausea, vomiting, retching, abdominal cramping, sweating, chills, prostration, weak pulse, shock, shallow respiration, and subnormal body temperature (FTI, 2004)

Associated foods

Bergdoll, (1979) intimated that *S. aureus* is mostly inhabit the nose and throat (and thus on the hands and fingertips) and on the hair and skin of healthy individuals. Any food which requires handling in preparation may therefore easily become contaminated. Staphylococci are thus expected to exist in all foods of animal origin and handled directly by humans. BBB noted that the major foods usually implicated in staphylococcal food poisoning include meat and meat products; poultry and egg products; salads, such as egg, tuna, chicken, potato, and macaroni; bakery products, such as cream-filled pastries, cream pies sandwich fillings; and milk and dairy products.

Viral foodborne diseases

FDA (2001) noted that despite the fact that viruses cannot thrive on/in food, their presence in fresh produce serves as vehicles for infection.

Hepatitis A viral infection

Hepatitis A viral infection (HAV) is caused by Hepatitis A virus. It affects mostly children and young adults, especially under conditions of overcrowding and poor sanitation. The BBB noted that Hepatitis A virus (HAV) particles are environmentally hardy organisms transmitted through contaminated food, water, surfaces such as contaminated table tops, cooking utensils and through direct or indirect person-to-person contact. Hepatitis A has an infective dose of below 10 to 100 viral particles and mortality of about 2.4%. Increased age (over 50 years old) slightly increases the death rate. The Infective Dose: The infective dose of HAV is presumed to be low (10 to 100 viral particles), although the exact dose is unknown. The viral particles are excreted in the feces of ill people (symptomatic and asymptomatic) after 36 days post-infection. The onset of the disease range 15 to 50 days after infection. The symptoms of HAV infection include fever, anorexia, nausea, vomiting, diarrhea, myalgia, hepatitis, and, often, jaundice. The route of entry for the foodborne infection is oral.

Associated foods

The foods associated with HAV include sandwiches, fruits and fruit juices, milk and milk products, vegetables, salads, shellfish, and iced drinks. ICMSF (1978) observed that contaminated shellfish may be a source of hepatitis A virus. Bidawid (2000) in this connection intimated that fecally contaminated food and water are the main vehicle for the transmission of HAV. Clayton et al,(2002) and Todd et al,

(2007) are of the view that since HAV can be introduced by unwashed hands of food handlers who are themselves infected, good personal hygiene and sanitary handling practices in the food processing are essential components of any prevention programmes for food safety

Hepatitis E infection

Hepatitis E is caused by a hepatitis E virus and has an extensive host range, including primates, pigs, rats, cattle, chicken, and sheep. Like other forms of hepatitis, this one causes inflammation of the liver. Hepatitis E virus which can be transmitted through consumption of undercooked meat, viral foodborne infections are limited to the recycling of human viruses back to humans (EFSA, 2011). (FDA 2012) intimated that the disease has a fatality rate of up 4 % and 27 % in the case of pregnant women. Incubation period following exposure can range from 3 to 8 weeks. Symptoms include jaundice, malaise, anorexia, abdominal pain, arthralgia, hepatomegaly, vomiting, and fever. HEV is transmitted by the fecal-oral route.

Associated foods

Food safety concerns arise when human and swine agricultural waste is used for irrigation of produce, such as tomatoes and strawberries, likely to be eaten raw and potentially without washing, or when such waste contaminates waters where shellfish are harvested (FDA, 2012)

Rotavirus

FDA (2012) noted that they are stable at low temperatures of -20°C and 4°C, with minimal loss of substance concentration after 32 days, and are stable during 6 freeze / thaw cycles. Rotaviruses are stable for up to 4 days at 37°C and rapidly inactivated at 56°C. Gibson *et. al* (2006) reviewed data which suggests that the number of particles of rotavirus and hepatitis A virus shed per gram of faeces is approx. 10¹⁰-10¹¹ cfu/g. Widdowson *et al* (2005) indicated that rotavirus is the leading cause of gastroenteritis in children less than 5 years of age in the US. Increases in the number of children suffering from rotavirus gastroenteritis in hospital pediatric units were correlated with an increase in the number of environmental surfaces contaminated with rotavirus (Soule *et al.* 1999). The disease has a mortality rate of 0.5 million deaths per year, worldwide with an infective dose of 10 to 100 infectious viral particles and an incubation period estimated to be less than 48 hours (FDA, 2012). The symptoms include watery diarrhea, to severe disease characterized by vomiting and fever. Most people get better in 3 days to a week. But the illness may be much more serious in some people, especially very young children, premature babies, elderly people, and people with weak immune systems or who are on certain medicines, such as some drugs used for rheumatoid arthritis.

Associated foods

Foods such as salads, fruits and others that do not require further cooking and are handled by an infected food worker may transmit rotaviruses. Person-to-person fecal-oral spread is the most important means of transmission. In this connection, Gwaltney *et al* (1980) noted that 13 out of 14 individuals who touched rotavirus-contaminated plates with their fingers and put the fingers to their mouths, about half became infected.

SOME PARASITIC FOODBORNE DISEASES

Giardiasis

Giardiasis is a parasitic foodborne disease caused by *Giardia duodenalis*, a one-celled, microscopic parasite that can live in the intestines of animals and people. The FDA (2012) observed that *Giardia* is infective in the cyst stage and the reservoirs for *Giardia* include the intestine of infected humans or other animals (cats, dogs, cattle, deer, and beavers). Ingestion of one or more cysts may cause the disease and the onset of the disease is 1 to 2 weeks after ingestion of a cyst(s).it enters the human host through the mouth. *Giardia duodenalis* infections sometimes are asymptomatic. However when symptoms are present they include diarrhea, abdominal cramps, gas, and nausea. Symptoms may last 2 to 6 weeks in otherwise healthy persons, but there may cases of chronic illnesses lasting months or even years (USDA, 2012). *Giardia* cysts may be released in the stool for weeks and even months and may be present in concentrations as high as 10⁷/g (FRI 1998).

Associated foods

Infection typically results after ingestion of soil, water, or food contaminated with faeces of infected humans or animals and infected food handlers are very often implicated in giardiasis outbreaks, suggesting the ease of foodborne transmission (FDA (2012). USDA (2012) is of the view that giardiasis is mostly linked with drinking contaminated water, but some people might get infected by consuming uncooked meat contaminated with *G. duodenalis* cysts.

2.9.9 Amoebiasis

Entamoeba is single-celled protozoan parasites. The sickness is caused by the organism *Entamoeba histolytica*. All species are characterized by a life cycle that alternates between two distinct stages namely the cyst stage and the trophozoite stage. The cyst stage is infectious but cannot replicate as the trophozoite stage is replicating. The trophozoite stage reproduces other cyst through binary fission. The FDA (2012) intimated that among all the species of *Entamoeba known only Entamoeba histolytica*, causes invasive disease in humans. The infective dose in human is less than 10 cyst. The disease condition usually manifest within 2 to 4 weeks after first exposure to this parasite although invasive intestinal condition may occur days to years after initial infection. Amoebiasis is believed to be the third leading cause of death with a fatality rate of about 26 % in children and 2 % in adults (FDA, 2012). The symptoms include liver abscess is characterized by fever, pain in the upper right abdomen, nausea, unintentional weight loss, and liver tenderness. It is also characterized by mild diarrhea to a severe, dysentery-like illness with mucus and blood in the diarrhea and abdominal distention. The primary mode of infection is the fecal-oral route.

Associated foods

Once the parasites are excreted into the environment, fecal contamination can result in *E. histolytica* cysts in drinking water, foods, hands, surfaces, and other objects. Water is the most common source of contamination. Raw food may also be a source of infection, after contamination by a food handler or by irrigation / rinse water, especially if the food is maintained in a moist environment. Food borne transmission is often associated with an infected food handler and also occurs

when produce is freshened or crops are irrigated with contaminated water. Flies, cockroaches and other insects may also transfer cysts from faeces to foods (FRI 1998).

Health Implications

Food vendors generally lack adequate knowledge of handling ready-to-eat foods. Most of the food vendors wash their utensils in a bowl of water with soap and hardly do they change the bowl of water used in washing the utensils. Under such conditions, certain food borne pathogens could be transmitted to others and cause cross-contamination. In urban Schools for example, students who eat from such serving plates are highly prone to contract food borne diseases. On the issue of raw vegetables, it is known that some vendors treat them with vinegar or salt solution; but the majority of them either washed the fresh vegetable with water or wiped them with napkins. Under this condition most pathogens remain on the fresh vegetables and cause food borne diseases when ingested. Furthermore these food vendors are normally not trained in food handling and on hygienic ways of handling food in the canteen. This trend of affair might be attributed to the fact that most of the food vendors were only trained at home from parents or guardians. Mitakakis *et al.* (2004) observed that food handling and storage practices in the home are major risk factors for gastroenteritis. This observation is in line with that made by El-Sherbeeney *et al.*, (1995), and Bryan *et al.*, (1992).

Conclusion and Recommendation

Food vendors operated in an insanitary environment in the school canteens; a condition that could lead to transmission of food borne pathogens and the subsequent outbreak of food borne diseases. Furthermore, there is low microbial quality of cooked foods normally sold in the schools and a generally low level of knowledge among food vendors on food borne diseases. It is therefore recommended that monitoring of foods sold in the various school canteens be conducted by the regulatory authorities (e.g. municipal environmental and sanitation directorate) as quality checks and a need to adopt policies to regulate and ensure that school canteens are strategically located and not close to unsanitary environments.

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