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Research Article

FOOD CONTAMINATION: IT'S STAGES AND ASSOCIATED ILLNESS

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ABSTRACT

Food contamination is the spoilage of food with contaminants such as microbes, toxins, heavy metals, environmental contaminants etc and Food Microbiology is the study of microorganisms that are present in foods and leads to contamination of food. This includes the study of microorganisms causing food spoilage; as well as pathogens that may cause disease due to improper cooking or storage of food. These microbes are also used to produce fermented foods like cheese, yogurt, bread, beer, wine and are even used in probiotics. The primary focus of food microbiology is food safety. There are many microbes like bacteria, viruses etc which gets transmitted through foods. Food safety is the discipline that deals with the food preparation, handling, processing, storage, distribution and its transportation in such a way that it does not gets contaminated during any of these processes. The major role of food safety is the prevention of any food borne illness and diseases. When food safety is neglected or care with food is not taken food borne disease outbreaks can occur. Outbreak is defined as a situation in which more than two cases occur from a common source and have same impacts on health. The consumption of contaminated food can result in hazards (physical, chemical, biological and allergenic) and hence its prevention and control is necessary. The process of food safety must be followed from the initial stage to its end stage which means from its origin to its consumer. Food safety is also associated the quality of water used for its irrigation, preparation and storage. This review paper discusses about the food contamination through different stages (pre harvest, harvest and post harvest), the diseases and illnesses caused by food contamination along with its prevention.

Keywords: contamination, food, hazard, food borne diseases, meat and fish.

1. INTRODUCTION

Food is defined as any substance that is edible and portable too, originating either from plant or animal source. (David R. J. et al; 2012) Food is ingested by each and every living being on the planet Earthand that is why it poses a great threat for disease transmission. Food sustains life and helps in providing energy, growth and maintenance of health of body. (David R. J. et al; 2012) Food acts as a vehicle for transmission of diseases specially when gets contaminated with harmful microbes, microbial toxins and other environmental contaminants. (Alum, E. A. et al; 2016) Spoilage of food has always been a challenge to mankind and this is because food nutrients act as a great source to microbes for their growth. (Ajay Kumar V. J. & Mandal P. K; 2020) Food contamination is defined as the spoilage of food due to bacterial growth or toxic substances present in it. In simple words, any substance in food that reduces the safety or quality of food is called food contamination. Food contamination can be intentional or accidental or even natural. Some may be able to see it with naked eyes like fungal or mould growth but in general food contamination can't

be seen with naked eyes i.e. bacterial growth mostly. The contamination can be due to microbial toxins produced by bacteria, parasites and virus. Some of their bacterial products may be used to combat these pathogenic microbes. Probiotic bacteria i.e., bacteriocins can kill and inhibit pathogens. Alternatively, purified bacteriocins like nisin can be added directly to food. The foods which are at high risk of contamination includes poultry, eggs, dairy, sea foods, green leafy vegetables & fruits, rice, sprouts and deli meats. Proper cooking of food also eliminates bacteria and viruses. However, toxins produced by contaminants may not change to non toxic ones by heating or cooking. Foods such as meat and meat products have rich nutrient content and are able to get contaminated easily. (Arun K Das et al; 2019) The contamination of these products can occur at any stage of production. In some countries, meat product's slaughtering is done on unhygienic equipments and environment conditions which lead to contamination. (Arun K Das et al; 2019) These microbes can also be helpful in preserving the food items such as by the process of fermentation. For most of the people around world, meat and its products are the first choice for protein source and hence the consumption is increasing. (Ajay Kumar V. J. & Mandal P. K; 2020) With this many products are spoiled each and every year, with poultry and meat weighed 3.5 billion kg wasted by people at different levels and showed substantial impacts environmentally and economically. Apart from microbes being used for fermentation, they are a great reservoir for disease transmission which can also lead to death. Many of the developing countries are the main victims of food borne diseases and therefore food safety is emerged as challenge globally. (Akhtar. S., et al;2014) The microbes are capable to resist themselves against antibiotics and that is when the major concern starts. Developed countries can also gets affected and their 1/3 population develops food borne illnesses annually. Even several efforts are being taken for food safety still food borne diseases is major health concern because it leads to significant morbidity and mortality. (Baluka, S. A., et al; 2014) The bacteria such as *Esherichiacoli*, *Staphylococcusaureus*, *Bacilluscereus*, *Pseudomonas*, *Coliforms*, *Salmonellaspp*., *Listeriaspp*., *Shigellaspp*., *Clostridiumspp*., *Yersiniaspp*., etc are capable to contaminate food. The microbes are also capable to grow when cooked food is reheated several times. Not only bacteria can contaminate food, but there are some other agents also. Some chemicals like toxins, heavy metals etc can also contaminate the food. The contamination can occur any stage of food production from farm to table. Each and every step in food production is crucial as well as vulnerable to contamination. It is not necessary that food gets contaminated during these stages but also cross contamination can occur, therefore proper care should be taken to prevent contamination. (Fig. 1)

There are different types of food contamination such as Physical Chemical and Biological. Many strains of bacteria and viruses which have the potential to cause illness in human comes under biological contaminants. Some illnesses may also caused by parasites and chemicals. (Fig. 2)According to Australian Institute of Food Safety, The contaminants such as hairs, insects, stem, etc,those are physical objects and are capable of contaminating are called physical contaminants and they cause physical hazards and the contaminants such as heavy metals, toxins, pesticides, fertilizers etc, or substances that have some chemical composition and are capable of inducing chemical toxicity and causes chemical hazards. Biological contaminants involve all the viruses, bacteria, and parasites. For example: *Esherichiacoli*, *Staphylococcusaureus*, *Salmonellaspp*., *Clostridiumspp*., etc. Each strain and species is capable of causing toxicity and different diseases in human beings. Environmental contaminants are the chemicals that are present in environment where food is grown or animals are raised. The environment conditions that causes contamination are air (pollutants like lead, SOx, NOx, etc), water (metals like mercury, arsenic, lead, chromium etc.), soil (cadmium, nitrates, microorganisms etc), natural toxins like mycotoxins, ciguateratoxins, scombrotoxins etc., packaging materials like BPA (BisPhenol A), copper, processing equipments etc. In India, most of the food diseases and illness are not investigated and comes under notice when damage to health and economic have been caused, (Foodborne Diseases and Food Safety in India.CD Alert, 2017) and identification of causing factors is a difficult task in such situations. However, the prevention of such diseases is area of interest in food safety. Most of these diseases are caused by bacteria and its toxins and toxin formation takes place in food before its consumption. (Ramesh V Bhat, Nageswara Rao R. et al: 1987)

The following review paper is hence an attempt to provide information about the food contamination, diseases and illnesses, contamination through varying stages, and its prevention.

2. PATHOGENIC AGENTS AND ILLNESS

The consumption of food which is contaminated leads to food borne illness. The contamination can occur due to presence of microbes and

pathogens in food. Most food borne diseases are either infections or poisonings caused by bacteria, viruses or parasites and harmful toxins or chemicals respectively. Food borne pathogens can also be acquired through drinking water, consumption of food cooked with contaminated water, contact with animals or their environment or through person to person spread. (Table: 1) Also, Food borne illness is an infection caused by food or beverages that contain harmful bacteria, parasites, viruses, or chemicals. Most of the food borne illness is acute, which means, they lasts for short duration. Most people recover on their own without any treatment simply by keeping their body hydrated. These symptoms can last from few hours to several days depending upon its range of mild to serious. The agents for food borne illnesscan be any physical, chemical, biological and environmental contaminant but the most common invisible agents for food contamination is bacteria.Bacteria is present everywhere and can grow wherever provided with favourable environmental conditions. However, some of the bacteria are non-pathogenic that means they does not poses virulence, they are usually enumerated not detected because they are present almost everywhere outside and within the body. Some of the common illness caused by pathogenic includes: Shigellosis, Salmonellosis, Listeriosis, Camplylobacteriosis, Botulism, *Esherichiacoli* infection etc.

Botulism: The disease is caused by bacteria *Clostridium spp.,* like *Clostridiumbotulinum*, *Clostridiumdifficile*, *Clostridiumperfringens* and *Clostridiumtetani*. (Akhtar. S., et al; 2014) The ingestion of canned food items which are prepared at home causes the disease. The heat resistance spores are capable to survive in these foods. The growth of Clostridium botulinum results in formation of potent neurotoxin (in 7 different forms) which causes neuroparalytic syndrome in living beings. (Skarin et al; 2011) The disease may result in death. The organism can thrive in favourable growth conditions like temperature, acidity, oxygen, and water acidity. The conditions whenever found in food poses health risks and mortality rate.

Shigellosis: The disease is common in children. Worldwide almost 600.000 children (under 5 years) die because of shigellosis. (Akhtar. S., et al; 2014) The disease is caused by sera-groups of *Shigellaspp*., like *Shigellasonnei*, *Shigellaboydii*, *Shigellaflexneri*, *Shigelladysenteriae*. The symptoms of disease involveabdominal pain, vomiting, fever, diarrhoea (watery and bloody), mucus and pus.

Campylobacteriosis: This is caused by bacteria *Campylobacterjejuni* and is common worldwide. The disease is caused by bad food handling practices and poor hygiene. The victims of infection are mostly not priviledged or have access to safe drinkingvwater and sanitary conditions. (Soofi et al., 2011; WHO, 2002) In developing countries there is lack of treatment facilities which aggravates the disease. (Akhtar. S., et al; 2014) Also, the infected people are at risk of developing GullienBarre Syndrome or GBS a neurological disease (Tam et al; 2007) which starts with finger numbing.

Esherichiacoli infection: E. coli is a marker for fecal contamination and is part of human, mammals and bird's gut. Many of the strains of E. coli are not hazardous but they may cause some intestinal disorders. The symptoms of all infections depend upon the strain which has caused the infection.

Salmonellosis: The disease is caused by group of enteric bacteria which is gram negative. The bacteria is poisoning in most of the developing and developed country worldwide. (Akhtar. S., et al; 2014) The symptoms involves Fever, headache, nausea, vomiting, abdominal pain, diarrhoea. The disease causing agents could be *Salmonellaenteritidis*, *Salmonellatyphi*, *Salmonellaparatyphi*. The transmission of disease is usually from poultry, eggs, and meats. *Salmonellatyphi*, *Salmonellaparatyphi*are commonly dangerous in developing nations and societies due to lack of access to safe drinking water and food.

Listeriosis: The disease is usually caused by a spore forming bacteria called *Listeriamonocytogene*. Although, there are many different species and strains of *Listeria* capable of causing listeriosis such as *Listeriaivanovii*, *Listeriainocua*, etc. The disease is common in people with immune-suppression. The source of disease could be milk, cheese, fish, and vegetables. The bacteria is capable to grow under cooling temperatures also. (Moretro&Langsrud, 2004)

3. STAGES OF FOOD CONTAMINATION

The food contamination can occur at any stage from start to end i.e. from farm to fork. This is very crucial to identify that what is the major source of contamination. The food gets contaminated very quickly and easily at any stage, so proper care and sight is needed to prevent and control it. There are no certain stages of food contamination but it can be classified under pre- harvest, harvest and post-harvest.

3.1 Pre- harvest contamination

This is the stage which involves the growing of food in field (plant source) and animals being raised to slaughter in future (animal source).

Some of the chemicals are already present in food as a result of environmental contamination. (Nerín, C., et al; 2016) Microorganisms, pathogens, heavy metals, pesticides and other harmful chemicals can contaminate the food either by soil grown upon or the water used to irrigation. This could also result due to excessive use of fertilizers and pesticides. (Kobayashi. M., et al; 2011) The contamination can also occur from the worker if poor hygiene is followed. Water contaminated with microbes like *E.coli*, fecal *coliforms*, heavy metals like lead, arsenic etc used for irrigation and pesticide application can lead to food borne diseases and illness. Also, the animals being raised in animal houses given contaminated water causes diseases in animals and when these animals consumed as a part of food affects human health. The vegetables like lettuce, and carrots are susceptible to salmonella and *E.coli* because of their water holding capacity. Fishes and other sea foods get contaminated by water they live in. Heavy metals such as cadmium, lead, arsenic, mercury etc., might be a part of environment like air, water and soil on which food is grown (Zukowska. J., et al; 2008) and causes heavy metal toxicity in humans. There are plenty of toxins, heavy metals like lead, arsenic, PCBs etc, and microbes present in water when absorbs affects the health of fishes and other sea food items. Studies have shown that manures used as fertilizers may contain chemicals and other compounds which can have effects on the crops as well as on the health of living beings. The pathogens like E.coli O157:H7 present have the tendency to gain acid resistance and surviving low pH environments. E. coli O157:H7 can survive upto 21 months in animals like sheeps and when manures from these animals are used as fertilizers affects the crops and leads to contamination. (Kudva. I., et al; 1998) Animal origin food gets contaminated when feed with contaminated water and food. Also, the contamination begins while breeding processes and the quality decreases with increase in inhumane treatment. (Arun K Das et al; 2019) When these animals are ingested raw can cause illness in humans. Also the environmental conditions under which the animals are raised also affect the extent of contamination. For example, if animals are raised in close proximity of contaminated river or sewage system, the chance of infections increases. Workers following poor hygienic practices also lead to contamination in pre harvest stages.

3.2 Harvest stages

The contamination in this stage can occur from all the equipments used for harvesting such as knifes, blades, sickles, boxes, chippers etc by workers (Alum. E., et al; 2016) and also the containers used by workers to store the plant produce. The unwashed equipments can be a room for microbes and pathogens therefore it is necessary to sanitize the equipments and containers before use. Auto motors like tractors with blades used for sowing can contaminate the whole field if not sanitized and washed. Workers personal hygiene plays a major role here also because many items are harvested using hands. (Alum. E., et al; 2016) The meat and poultry can get contaminated in their pre slaughter and slaughter stages from feed lots, transport, lairiages etc. The feeding with infected food can cause meat and poultry to carry bacteria that can cause food poisoning. Other items like cloth, footwearsetc and insects, rodents, pets, animal and human feces can also contribute to contamination of meat and poultry. Use of contaminated equipments such as knife used for slaughtering can cause cross contamination. Fishes which are not grown via aquaculture poses a great threat to human health because the contamination goes unknown. During aquaculture, the environment of water affects the fish quality. Also, after fish catching, the surfaces and clothes on which they are kept, equipments used for their catching and cuttings also causes contamination.

3.3 Post- harvest stages

This is the last stage for food. This involves four more stages, which involves Food processing: the first stage after harvesting which involves the changing of plant or animal into edibles. There are so many different steps of food processing for each and every food item. For example: washing or sorting can be a process of food production. Other processes can involve slicing, trimming, shredding etc. (Monteiro, C. A.; 2010) For animal origin, slaughtering is first step of processing and these are chopped into pieces. The meat and meat products including poultry can be smoked, frozen or cooked and sometimes are mixed with other ingredients like potpie to make sausages. The contamination can occur when washing, packing and chilling of fruits and vegetables is done by using contaminated water and ice. Also, if the surfaces of processing units or storage bins are contaminated, cross contamination to food can occur in both plant and animal originated food. Most of the times, there are chances of final meat product getting contaminated with germs originating from animal's intestines. Another is Food distribution and transportation: The process of transferring food from farm to consumer's locations requires distribution and transportation. Locations such as grocery shops, restaurants, markets etc, which are far away

makes the distribution and transportation process complex. This is crucial step because the safety of food is at high risk. The cross contamination can occur from chemicals and disinfectants used for long distance ships. (Nerín. C., et al; 2007) The items are packed, segregated and distributed according to the demands of consumer. The packaging of food involves addition of additives like stabilizers, antioxidants, preservatives etc., in order to increase material's properties. (Nerín, C., et al; 2016) There are many points in this step which can cause contamination. For example, if frozen meats are meant to transport to consumer, it has to be loaded in a transport directly from processing units and are sent to supplier chain, there they are stored in warehouses for a certain period of time. This might provide the frozen meat favorable conditions during some of point of time and results in contamination before reaching its final destination. Meat and meat products should be packed in such a way to prevent environmental contamination before its consumption so as to bring meat safety. (Arun K Das et al; 2019)Additives added during the packaging of food might be migrants causing cross contamination. (Paseiro-Cerrato, R., et al; 2010) Also when food is not kept as safe temperature at the time of transport and distribution, food gets spoiled. The packaging of dry foods such as rice, flour, cereals etc involves the use of paper and board, which also leads to cross contamination. (Nerín, C., et al; 2016) Transporting of edible items with animals or in a van that just transported cattle (without disinfection and cleaning) causes cross contamination. For meat and meat products, if any biological hazard occur at this stage it will impact meat negatively. (Jenson, I., et al; 2014) The final is Food preparation: The stage which involves the cooking of food so that it is ready to consume. The preparation of food can be done anywhere in restaurant, home kitchens, institutions, offices, schools etc. (Alum. E., et al; 2016) The step involves the mixing of raw food with ingredients and spices, other processes like heating, boiling, baking, and finally serving. The contamination can occur from the hands of cook (if gloves are not worn), equipments (if not washed or sanitized) used for preparation such as knifes, chopping boards, spoons, and other utensils. (Alum. E., et al; 2016)The plant and animal origin food gets contaminated the same way in food preparation. The proper hygiene and sanitation should be followed by chef and regular washing and cleaning of equipments, surfaces should be done. The storage conditions of prepared food can also leads to contamination irrespective of refrigerator or freezer. If meat is stored with raw items, the juices from meat can slip into raw food causing cross contamination and this is more of a concern when that food is meant to consume raw.

4. PRECAUTIONS

The need to take precautions is necessary for mitigation of several diseases and loses. (Alum. E., et al; 2016) The loses are more costly then prevention and an economic analysis for costs related to food safety showed that the investment for prevention is a lot more cheaper than that of an after event. (Ribera, L. A., et al; 2012) The precautions of food safety can be involve proper sterile conditions should be maintained for food processing and storage, proper cooking should be done for raw foods, sterile packaging should be followed for packaged ready to eat food items, adequate temperature and humidity should be maintained in working environment of food, HVAC i.e. Heating, Ventilation and Air Conditioning systems should be installed in all the premises of food facility, storage and preparation area for both raw and cooked foods must be separated to avoid cross contamination, proper washing and cleaning of equipments used in food preparation, storage, transport and distribution should be done, regular food testing from random lots should be done for monitoring of hygiene qualities, quality Management System followed should comply with ISO 9000, proper cooking guidelines should be followed, swab collection from equipments and workers and its testing to monitor hygiene quality, awareness programs organized by professionals of companies to educate workers, proper sanitation, hygiene and quality checks done by officials, proper handling of food by workers should be done, the environmental should be maintained as such that no bacterial growth can occur. For example: storage of unused food items must be stored in refrigerator at $4^{o}C$-$8^{o}C$ and frozen meats and seas foods must be stored in deep freezers etc. The precautions can be taken on the basis of hazards such as physical, chemical and biological hazards. For physical hazards, elimination systems can be used such as detectors detecting metals, X-rays machines in case of animal foods. (Arun K Das et al; 2019) Similarly, for chemical hazards, removal of using fertilizers, pesticides, insecticides etc in the agricultural field can minimize the food contamination and all these are potent contaminants of environment as well and food contamination starts from milk, eggs, meat. (Smith, D. J., & Kim, M.; 2017 and Tilahun, A., et al; 2016)The discharge from industries includes heavy metals, toxins, waste and pollutes the field and water bodies which can act as a source of contamination for food. To overcome this,

enforcements by food safety regulations are to be followed. Biological hazards are very critical to control because this hazard can occur at any stage of food form farm to plate. To control microbial growth, controlling temperature, pH, humidity and moisture is necessary and ionizing radiations are used sometimes in case of animal food. (Sofos, J. N. 2008)

5. PREVENTIVE MEASURES

To regulate chemical levels in food, there are many legislations and regulating bodies. Food adulteration and unhealthy additives are not allowed legally. Therefore, for chemical hazard prevention, effective surveillance and response systems are necessary. The limits of chemicals such as pesticide concentration are assigned by FDA which are allowed to add in food. (Bajwa, U., & Sandhu, K. S., 2011) However, there are countries which depend upon agriculture and pesticides are seeped into ground water having food and water in high levels. (Rather, I. A., et al; 2017) The government has taken appropriate steps that minimizes individual exposure against food contaminants, however, there are many measures that that are still to be taken to reduce the diseases and health risks. (Rather, I. A., et al; 2017) During preharvest & preslaughter in order to remove pathogens adoption of GAP i.e. Good Agricultural Practices during crop development & harvesting must be done. (David, R. J., et al; 2012) The measures such as microbial testing of farm & water, fencing buildup to restrict animals, manure application, regular cleaning etc can be taken to prevent contamination at preharvest stage. For animal originated food, antibodies measurement should be done to know the status of infection. The more slaughtering methods are industrialized, the more risk is to infection. However, meat animals and carcasses are easily to get contaminated with bacteria. So, improvement of slaughter hygiene is necessary to prevent contamination. (Behravesh, C. B., et al; 2012) At harvest stage, contamination can be prevented by potable hand-wash station, equipment sanitization, etc. Some of the otherpreventive measures can include regular cleaning and sanitation of working premises and equipments should be followed with a detailed cleanliness program/ chart which details about frequency, procedure, area, material and method of cleaning and sanitation, cleaning in place (CIP) should be adopted in premises for all equipments, instruments, etc. Good hygiene practices should be followed and maintained, containers filled with chemicals should be properly labelled and stored away from food items. Food containers should never come in use to mix or transport chemicals and chemicals related products and lubricants used for equipments should be food safe, proper use of PPE like gloves, caps, glasses, apron etc, should be followed during the process. The health of personnel working in the food production, processing, storing, distribution and preparation must be diagnosed on regular basis, practice of hand washing with soaps & disinfectants and clean water should followed by personnel during entry and exit of food handling premises and after using toilets. Practices like smoking, chewing, spitting, coughing and sneezing should be prohibited in premises, outside footwear should be prohibited in working environment and long nails should be restricted in working environment and the design of facility should be designed in a way to avoid cross contamination with adequate cleanliness and avoidance of pest access and accumulation, storage conditions should be maintained to avoid favourable conditions for microbial growth. Conditions like temperature and humidity should be maintained, the items should be properly labelled and sealed packaged before sending it for transportation to avoid any leakage, spillage or spoilage of food items. The containers used must be in good quality and shape, also the vehicle used should be cleaned before loading packages into it. The workers handling the transportation process should maintain personal hygiene and sanitation to avoid cross contamination. The transport that is used for food delivery must be different from non food items. Transporting petroleum and hazardous chemicals with food items is restricted.

CONCLUSION

Food safety is the discipline that deals with the food preparation, handling, processing, storage, distribution and its transportation in such a way that it does not gets contaminated during any of these processes. The major role of food safety is the prevention of any food borne illness and diseases. When food safety is neglected or care with food is not taken food borne disease outbreaks can occur. The consumption of contaminated food can result in hazards (physical, chemical, biological and allergenic) and hence its prevention and control is necessary. The consumption of food contaminated with pathogens results in diseases and poisoning like Salmonellosis, Shigellosis, Campylobacteriosis, E. coli infection, etc and can lead to outbreaks and deaths in both developing and developed countries worldwide. The contamination of food can occur by improper hygiene and poor sanitation practices followed by workers. Also, each and every stage of food preparation is crucial to contamination and proper care is to be taken at every stage. To

minimize these incidents and contamination, good hygiene practices, good manufacturing practices should designed and followed regularly. Consecutive analysis and inspection of related areas should be followed to prevent contamination. Other than this, regular medical check-ups of staff and workers should be done.

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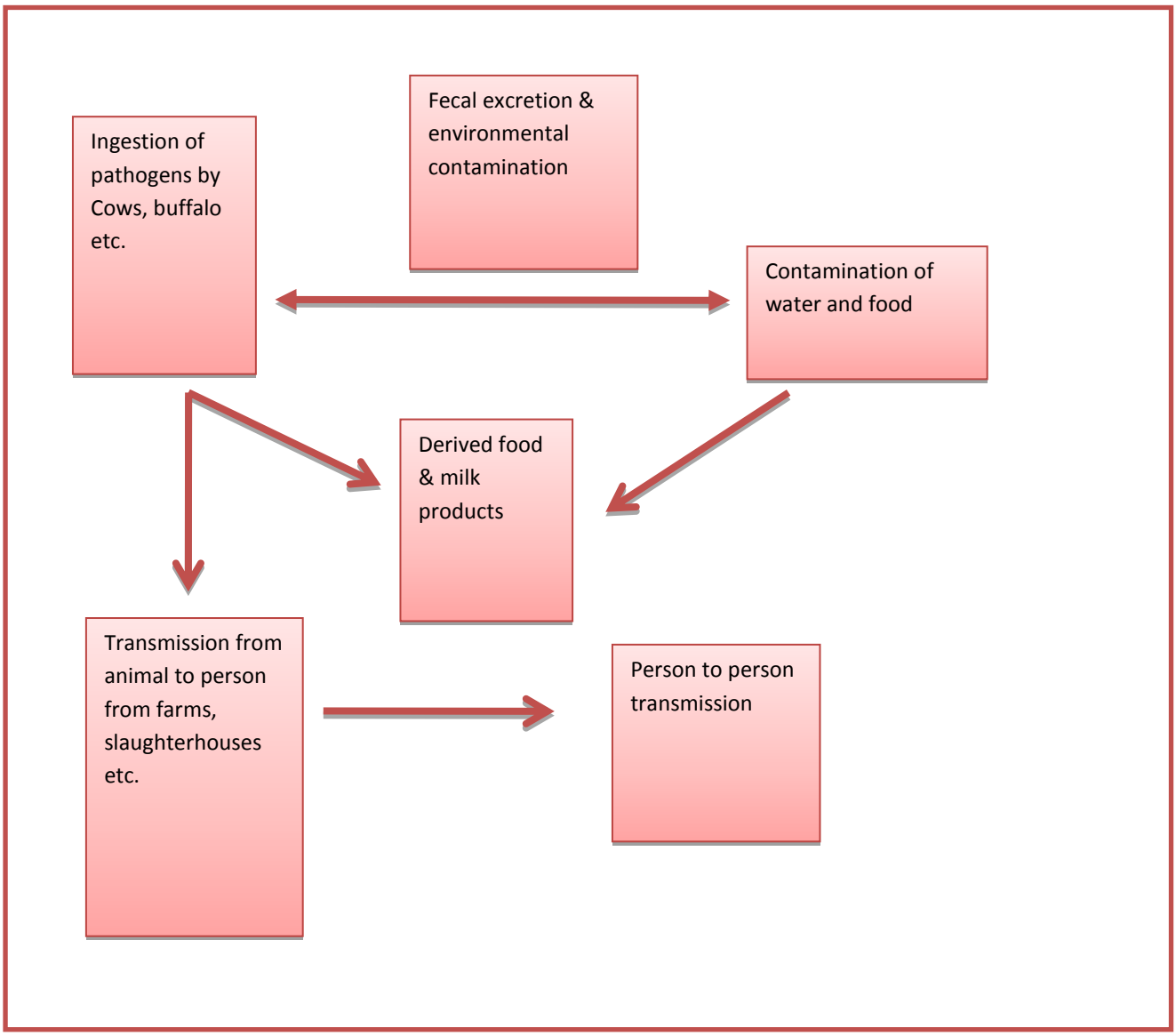

Fig. 1: Food Contamination Cycle

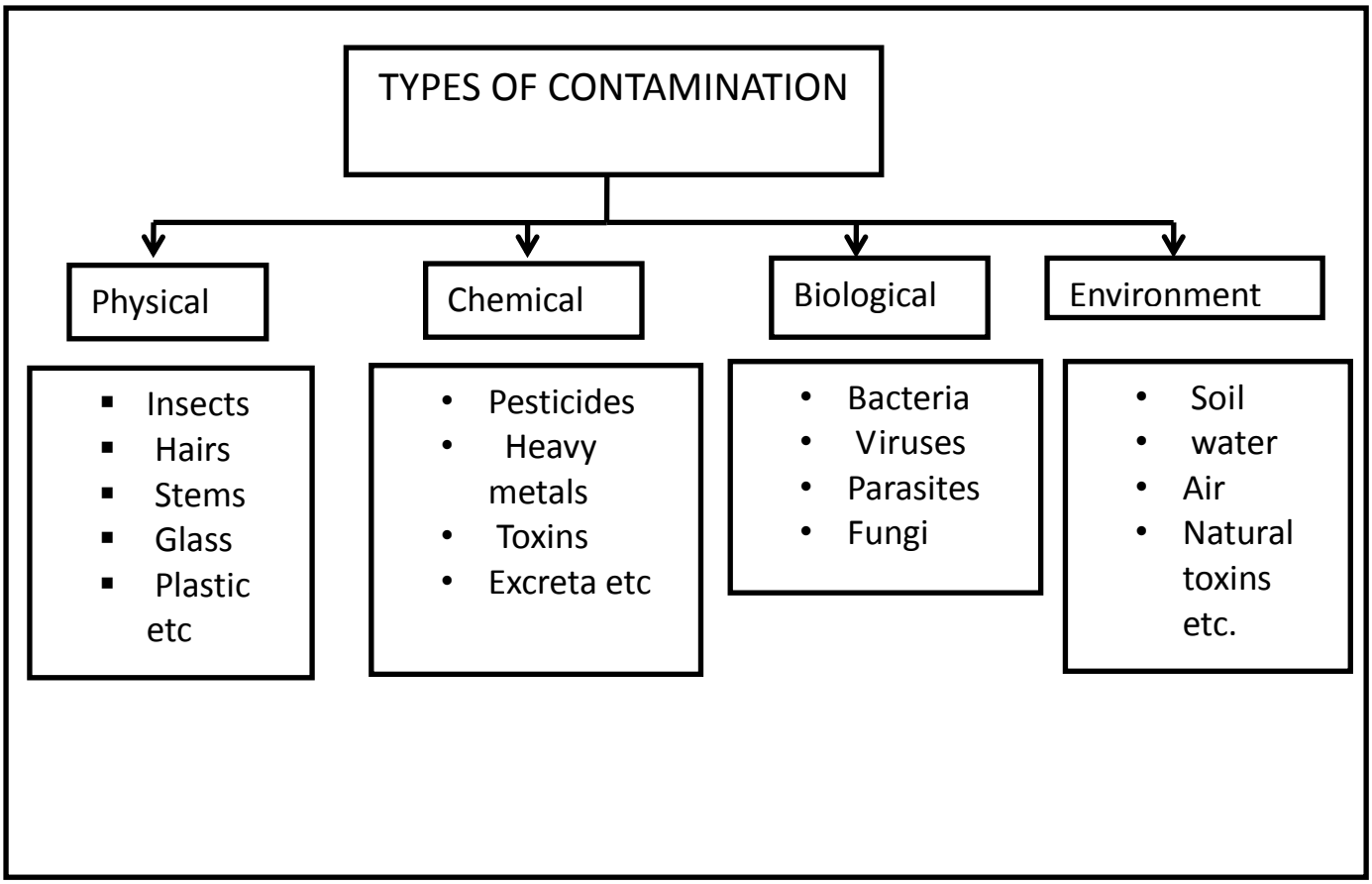

Fig. 2: Types of Contaminants

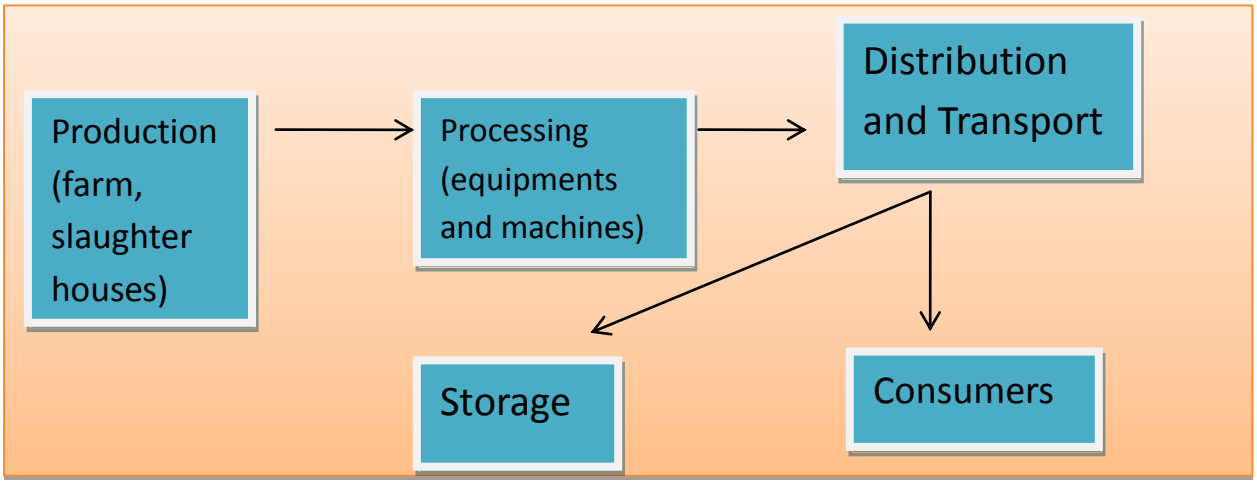

Fig. 3: Stages of Contamination

Table 1: Common food borne illnesses and symptoms
(Source: Centre for disease control & prevention, April 16, 2004)

S.No.	Disease	Causative agent	Source	Incubation period	Symptoms	Transmission
1.	Campylobac-teriosis	*Campylobacterjejuni*& C. coli	Domestic animals, livestock, birds, polluted water	Varying from days to weeks	Fever, chills, headache, prostration malaise, swollen lymph nodes	Ingestion of raw milk, poultry (undercooked), beef, pork, cross contamination
2.	E. coli infection	Enteropatho-genic E.coli	Humans	12-36 hours or 1-6 days	Vomiting, diarrhoea, abdominal pain fever, adheres mucosa	Ingestion of contaminated food & water with fecal matter
3.	E.coli infection	Enterotoxige-nicE.coli	Humans	10-12 hours or 1-3 days	Diarrhoea, cholera like syndrome, abdominal cramps, vomiting, dehydra-tion& shock	Ingestion of contaminated food & water with fecal matter
4.	E.coli infection	Entero-invasive E.coli	Humans	10-18 hours or 1-3 days	Inflammation disease of mucosa & sub mucosa, fever, abdominal pain, vomiting watery stools, diarrhoea	Ingestion of contaminated food & water with fecal matter
5.	E.coli infection	Entero-haemorrhagicE.coli	Cattles	3-8 days	Abdominal cramps, watery and bloody diarrhoea, fever, vomiting	Consumption of raw or undercooked meat products, raw milk from contaminated animals, fecal and cross contamination
6.	Salmonel-losis	Non- typhoid salmonella serotypes	Poultry animals, pig, cattles, rodents, pets, chicks, turtles	6-48 hours or upto 4 days	Fever, headache, nausea, vomiting, abdominal pain, diarrhoea	Ingestion of contaminated milk, meat, poultry, water, spices, salads and chocolates
7.	Typhoid and paratyphi fever	*Salmonellatyphi*& S. paratyphi	Humans	10-20 days	High fever, abdominal pain, headache, vomiting, diarrhoea followed by constipa-tion, rashes	Ingestion of contaminated milk, meat, poultry, water, spices, salads and chocolates
8.	Shigellosis (Bacillary dysentery)	Shigella spp.	Humans	1-3 days	Abdominal pain, vomiting, fever, diarrhoea (watery and bloody), mucus and pus	Ingestion of contaminated raw chicken, meat, undercooked vegetables, fecal matter, beef, pork, milk, salads
9.	Vibrio parahaemo-lyticus gastro-enteritis	*Vibrioparahaemoly-ticus*	Coastal sea water, estuarine brackish water, marine fish and shellfish	9-25 hours or upto 3 days	Profuse diarrhoea, abdominal pain, vomiting and fever	Consumption of raw or undercooked fish or fishery products, cooked foods with subjects to cross contamination from raw fish
10.	Yersiniosis	*Yersiniaenterocolitica*	Animals like pigs	24-26 hours	Abdominal pain, diarrhoea, mild feces, vomiting	Ingestion of pork products (tongue, tonsils, gut), milk and milk products

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