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Microbiological Contamination of Food: The Sources, Impacts and Prevention

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Abstract—*A food that is safe and free from contamination and spoilage at all points in its journey from its source to consumers is the basic need. This basic need of man can cause devastating impacts if contaminated with pathogenic microorganisms/microbial toxins. The reliable supply of safe food that is free from harmful contaminants is important for the people's general health and daily life, economic development and social stability. One way to save people from all the detrimental impacts of microbiological contamination is to spread information and knowledge about the sources and routes of transmission of pathogens into food. Common microbial contaminants especially bacteria associated with food are E.coli, Salmonella spp., Shigella, Vibrio cholerae, Listeria monocytogenes, Bacillus cereus, Clostridium perfringens. The food which can be highly contaminated with these microorganisms are dairy and meat products, fermented foods, raw meat, vegetables, fruits, cereals and pulses, processed and ready to eat food. The diseases caused by pathogens found in contaminated foods are hemorrhagic colitis, diarrhea, vomiting, cholera, typhoid, listeriosis, gastroenteritis, abdominal pain and gas gangrene. Food contaminated with these pathogens is a serious issue because it can lead to a wide range of health problems. Food-containing harmful microorganisms are responsible for more than 200 diseases ranging from diarrhea to cancers [Bryan, F.L.,1982[1].This paper will address microbiological contamination of foods including their sources, types with their commonly associated foods, impacts and their prevention and control. The awareness of potential sources of food contamination can help to avoid food poisoning.*

1. INTRODUCTION

Food has been defined as edible or portable substances (usually of plant or animal origin) consisting of nourishing and nutritive components such as carbohydrates, fats, proteins, essential minerals and vitamins which (when ingested and assimilated through digestion) sustains life, generates energy and provides growth, maintenance and health of the body [2]. A food that is safe and free from contamination and spoilage at all points in its journey from its source to consumers is the basic need. This basic need of man can cause devastating impacts if contaminated with pathogenic microorganisms/microbial toxins. The reliable supply of safe food that is free from harmful contaminants is important for the people's general health and daily life, economic development and social stability. Foods despite their beneficial roles in the body, can also serve as vehicles for disease transmission and cause of death if contaminated with harmful microorganisms, microbial toxins or environmental contaminants (chemical allergens and Microphysical particles). A review of the medical literature has shown that microbiological contamination is more common than both chemical and microphysical contaminations [4]. The relative number of illness due to food borne microorganisms makes microbiological quality the most important food safety factor [22]. The contaminant of food can be biological, chemical or physical in nature, with the former being more common. The microbiological contaminants have several routes throughout the supply chain (farm to fork) to enter and make a food product unfit for consumption. Microorganisms causing contamination of food can enter the food chain through number of sources available in surroundings. Common microbial contaminants especially bacteria associated with food are *E.coli, Salmonella* spp., *Shigella, Vibrio cholerae, Listeria monocytogenes*, *Bacillus cereus*, *Clostridium perfringens* which can cause severe illness in human beings. The food which can be highly contaminated with these microorganisms are dairy and meat products, fermented foods, raw meat, vegetables, fruits, cereals and pulses, processed and ready to eat food. The diseases caused by pathogens found in contaminated foods are hemorrhagic colitis, diarrhea, vomiting, cholera, typhoid, listeriosis, gastroenteritis, abdominal pain and gas gangrene. Food contaminated with these pathogens is a serious issue because it can lead to a wide range of health problems.

2. SOURCES OF MICROBIOLOGICAL CONTAMINATION OF FOOD

Food is considered to be spoiled when the appearance, texture, flavor and odor is changed because microbes could have entered the food. These unpleasant changes can lead to food borne illnesses. Microorganisms can multiply into thousands within short duration and so food can deteriorates very fast if it has been contaminated by microorganisms. Bacteria, fungi and viruses are all microbial contaminants that cause changes in food. There are number of sources available for microbial contamination of food.

2.1 Harvesting and slaughter related microbial contamination

Microorganisms including pathogens can be introduced to the crop or food animals during primary production (in the farm where plants are grown or animals are raised for food (pre-harvest or pre-slaughter stages), at harvest and slaughter of food produce and food animals respectively and at postharvest/ post-slaughter (consisting of food processing, distribution and marketing, storage, preparation and serving). While being grown in the field, plant foods can get contaminated with microorganisms through contaminated water used for irrigation and application of pesticides containing microbes, manure applied as fertilizer and malfunctioned practices of workers in the field. In case of meat and poultry products, with feeding of infected foodstuffs to poultry can result in large numbers of chickens and their eggs carrying food poisoning bacteria [3]. Food processing and preparation are the practices used to make a change to a food to alter its eating quality or shelf life. Cross-contamination is the way to contaminate the food i.e directly (food to food) or indirectly (equipment/utensils or food contact surfaces to food and people to food). *L. monocytogenes* can be transferred from processing surfaces to foods [14]. One important factor of microbial contamination during food processing and preparation is food contact equipment which may harbor and introduce pathogens into food. Microbes from raw meat and poultry can be transferred from kitchen equipment, utensils, knifes, cutting boards and surfaces if they are not washed adequately between uses. When cutting boards used for raw meat, poultry or seafood come in contact with other foods, microorganisms can be transferred. *Listeria monocytogenes* has been found on equipment and process surfaces, which are difficult to clean [24]. Use of contaminated water for washing in food processing and preparation can provide chances of microbial contamination of food.

2.2 Hygienic related contamination

Another avenue through which foods get contaminated during processing and preparation is infected food handlers and their unhygienic practice [14]. When infected food handlers not suppose to wash their hands after using the toilet, handling raw meat poultry or fish, taking out garbage, cleaning up spills, touching other contaminated surfaces such as nose and open wounds food contamination takes place. Humans (their skin, mucous membranes and cuts, open sores or a skin infection) can serve as reservoirs of pathogens, e.g. *S. aureus* and from where foods get contaminated if handled under unhygienic condition, especially through unwashed hands [18].

2.3 Contamination through biofilm formation

Microorganisms including pathogens can inhabit or accumulate on critical places such as food contact and environmental sites on equipment to form biofilms (microbial cell clusters with a network of internal channels or voids in the extracellular polysaccharide and glycoprotein matrix, which allows nutrients and oxygen to be transported from the bulk liquid to the cells). Most of the microbes naturally have a higher tendency to produce biofilm than others. Food borne pathogens that readily form biofilms include *Bacillus cereus*, *S. aureus*, *M. paratuberculosis, C. perfringens*, *E. coli* 0157:H7, *S. typhimurium*, *C.jejunii*, *Yersinia enterocolitica* and *L. monocytogenes* [24].

2.4 Contamination during storage, transport and service

Contamination of food can also occur during storage in contaminated containers. During food storage at refrigeration, cross contamination takes place when raw food mixes with other ready-to-eat foods kept at same place for storage. During transport of food from market to home or from storage place to market for sale, microbial contamination can also occur through mishandling by sales persons or customers Dust particles, contaminated environment and decayed food part during distribution can also increases the number of microorganisms in foods. During serving of food, kitchen tools used for raw food such as meat, poultry and unwashed vegetables can come in contact with other food-serving utensils, during which microorganisms can be transferred directly from contaminated utensils to food. Cooked foods get contaminated if wrapped in contaminated package material that come in contact with the food.

3. FOOD BORNE MICROORGANISMS AND THEIR ILLNESS

Several pathogens were recognized only recently as a cause of food borne illness [23]. Food borne microorganisms are dangerous health hazards due to its presence in food and their toxin production can cause severe illness . For example, until 1982, *E. coli* 0157:H7 was not recognized as a significant human concern in association with the consumption of contaminated fresh fruits and vegetables [18]. Now, *E.coli* 0157:47 is common food pathogen causing illness wordwide. The similar microorganisms that can cause foodborne illness include bacteria [16] (*Clostridium perfringens*, *Staphylococcus aureus*, *Clostridium botulinum*, *Listeria monocytogenes* [19], *Escherichia coli* OI57:H7, *Salmonella, Yersinia enterocolitis, Campylobacter* species (*C fefunii* susp *fefunii*, *C. coli*, *C. lari*, *C. fetus* subsp. *fetus* and *C. upsaliensis*), *Bacillus cereus*, *Shigella*, *Lactococcus cremoris*, *Vibrio cholerae* and toxins produced by bacteria and fungi. In order to trace the transmission routes, types and extent of contamination caused and impacts of food borne pathogens, we have analyzed different categories of food samples such as dairy and milk products, meat products, fermented foods, raw meat, vegetables, fruits, cereals and pulses, processed and

ready to eat food following Indian Standard procedures. After analyzing near about 50 food and vegetable samples, we found that all the mentioned food borne microorganisms were found after confirmation of results. Hence, we inferences that highly contaminated food with these food borne pathogens are being sold in food selling stores which may lead to serious health problems.

4. MATERIALS AND METHODS

10 samples of 5 categories of food and vegetables were taken. 100gm of each solid sample was taken with sterile forceps in sterile plastic zipper bag. Total 50 samples suppose to be contaminated were analyzed for detection of food pathogens. Samples were analyzed for detection of total plate count, coliforms, *Staphylococcus aureus, bacillus cereus, salmonella, shigella, vibrio cholerae and listeria monocytogenes*. All the samples were transported to laboratory and analyzed within 1 hour of collection or refrigerated at 4°C before being analyzed.

Microbiological Analysis: Microbiological analysis of food, Fruit &vegetables and cereal & pulses samples was done as per IS 5401, 5402, 5887 (Part 2), 5887 (Part 3), 5887 (Part 5), 5887 (Part 6), 5887 (Part 7) and ISO 11290(1).

4.1 Total plate count:

It was determined by transferring 10g of the sample into flask containing 90ml 0.1% peptone salt solution working as diluent. This is the intial dilution of 10^{-1}. Further dilutions upto 10^{-5} were prepared from initial dilution. One ml aliquot from 10^{-1}, 10^{-2}, 10^{-3} , 10^{-4} and 10^{-5} dilutions were transferred into duplicate petri-dishes. This was followed by pouring aseptically 20-25 ml of molten plate count agar (PCA). The inoculum was mixed by swirling the plates and later allowed to solidify.The plates were incubated at 30°C for 72 hours. After incubation, plates containing 30-300 colonies were selected and the colonies counted and recorded. The average was taken and the number obtained was multiplied by inverse of the dilution factor. This gave the number of colony forming units per gram of each sample (cfu/g)(IS 5402,2002 ISO: 4833: 1991) [6].

4.2 Enumeration of coliforms:

One ml sample from different dilutions was poured in sterile petri-plates (in duplicate for each dilution) and then 15-20 ml sterile crystal violet neutral red bile lactose agar medium was poured. After mixing, plates were allowed to set and incubated at 37 °C for 24-48 hrs. Purple colour colonies having diameter of 0.5mm were counted after incubation. The average number of colonies was taken and the number obtained was multiplied by inverse of the dilution factor. This gave the number of colony forming units per gram of each sample (cfu/g) (IS:5401,2002 ISO: 4832: 1991) [5].

4.3 Detection of *Staphylococcus aureus*

10g of the sample was added into 90ml of Cooked meat medium with addition of 10% sodium chloride. This is the intial dilution of 10^{-1}. Further dilutions up to 10^{-5} were prepared from initial dilution. 0.1 ml was streaked on the plates of *Bair*d *P*arker agar and plates were incubated at 37^0C for not less than 30 hours. After incubation, plates containing less than150 colonies were selected and the colonies counted and recorded. Shiny black colonies with narrow gray white margins appeared after incubation were confirmed by coagulase test and Gram staining. The average number of colonies was taken and the number obtained was multiplied by inverse of the dilution factor. This gave the number of colonies forming units per gram of each sample (cfu/g) (IS:5887-Part 2, 1976) [7].

4.4 Enumeration and detection of *Bacillus cereus*

0.1 ml of each dilution (10^{-1}, 10^{-2} and 10^{-3}) was spread on MYP agar plates which were incubated at 30 °C for 18- 24 hours. Numbers of presumptive colonies (large pink colonies surrounded by zone of precipitation) were counted from each plate containing less than 150 colonies. Five presumptive colonies were selected from each plate and confirmed by stab inoculation in glucose agar tubes, VP test and nitrate test and Gram staining. The average was taken and the number obtained was multiplied by inverse of the dilution factor. This gave the number of colony forming units per gram of each sample (cfu/g) (IS: 5887 -Part 6, 2012, ISO7932:1993) [8].

4.5 Detection of *Salmonella*

25 g of sample was added to 225 ml of sterilized buffered peptone water and incubated at 37 °C for 24 hours. 0.1 ml was transferred to a tube containing 10ml of RV medium and another 10 ml to a flask containing 100ml Selenite cystine medium. The inoculated RV medium was incubated at 42 °C and the inoculated sterile Selenite cystine medium at 37°C for 24 hours (enrichment). A loopful from the enrichment medium was streaked onto BGA and XLD plates and incubated at 37 °C for 24 hours. Suspected red colonies with black centre from each plate were streaked on nutrient agar plates and incubated at 37 °C for 24 hours. After incubation colonies were confirmed with biochemical and serological tests. Result noted as absent/Present/25gm (IS: 5887-Part 3, 1999 [9].

4.6 Detection of *Shigella*

25 g of sample was added to 225 ml of sterilized nutrient broth and incubated at 37 °C for 24 hours. After incubation 0.1 ml was transferred to a tube containing 10ml of tetrathionate broth and 10 ml of selenite -F broth and tubes were incubated at 37oC for 24 hours. Plate out a loopful of growth on deoxycholate citrate agar medium and incubated the plates at 37oC for 24. Typical colonies appeared as opaque, with ground glass appearance and with even margins. The colonies were confirmed with biochemical and serological tests and result noted as absent/Present/25gm(IS 5887 Part7, 1999) [10].

4.7 Detection of *Vibrio Cholerae*

25gm of sample to 225ml of pre sterilized alkaline peptone water for enrichment and incubated for overnight at 37^{o}C. After incubation TCBS and bile salt agar media plates were inoculated with pre enrichment broth and incubated at 37^{o}C for overnight. The colonies of *Vibrio cholerae* appeared after incubation were yellow in colour with entire round margins on TCBS. The colonies were confirmed with biochemical and serological tests and result noted as absent/Present/25gm (IS 5887 Part5,1976) [11].

4.8 Detection of Listeria monocytognes

25 g of sample was added to 225 ml of sterilized primary enrichment (half Fraser) broth and incubated at 30 ± 1°C for 24 hours. Subcultured 0.1 mL of the incubated primary enrichment (half Fraser) broth to 10 mL of secondary enrichment (Fraser broth) and placed in an incubator at 37 ± 1°C 2 4hrs. After incubation, PALCAM agar and oxoid agar plates were inoculated with secondary enrichment (Fraser broth) and further plates were incubated at 37^{o}C for 24 hours. Colonies of *Listeria monocytogenes* appeared as grey-green with a black precipitation were confirmed by means of biochemical and CAMP test and result noted as absent/Present/25gm ISO: 11290(1) [12].

5. RESULTS

The results of microbiological analysis of 50 samples of food and vegetables are presented in table-1. As evident from table-1, the total plate count is very high in all samples. In dairy and milk products samples, highest plate count is in DM-1(215x10^{4} cfu/gm) and highest coliform count is in DM-8(176 cfu/gm) which is higher than permissible limit. All samples of dairy and milk products were contaminated with *S.aureus* and highest *S.aureus* count is in DM-5.

Samples of dairy and milk products were also contaminated with *Bacillus cereus* pathogens which is highly dangerous. Highest *B.cereus* count is in DM-7(92 cfu/gm). Out of 10 samples of dairy and milk products, 6 are positive for *Salmonella*, 3 are positive for *Shigella* and 3 are positive for *Listeria*. Hence, dairy and milk product category of food samples is highly contaminated as per our study.

In ready to eat samples category of food, highest bacterial count is in RTE-8(215x10^{3} cfu/gm), highest coliform count in RTE-10(72 cfu/gm) which is supposed to be responsible for fecal contamination of food. *S.aureus* count is highest in RTE-8 (67 cfu/gm) and *B.cereus* is highest in RTE-2(105 cfu/gm). Hence, RTE-2, RTE-8 and RTE-10 were highly contaminated as compared to other RTE samples. Although RTE-9 is containing less number of bacterial count as compared to rest of RTE samples but it is Positive for pathogen *Salmonella*.

In meat product category of samples, almost all samples are highly contaminated with pathogens but highest plate count is in sampleM-1(299x10^{4} cfu/gm),highest coliform count is in sample M-3(1600 cfu/gm)and highest *S.aureus* count is 208 in sample M-1. *B.cereus* count is highest in in two samples M-5, M-10 (102 cfu/gm). Meat products samples M-3, M-5,M-10 are positive for *Salmonella* and *Listeria monocytogenes* while sampleM-1 and M-8 are positive for *Salmonella* ,*Shigella* and *Listeria monocytogenes.* Meat sample M-4 is positive for *Listeria monocytogenes* along with very high coliform count. Out of selected 10 meat product samples, 7 are contaminated with *Salmonella* ,*Shigella* and *Listeria monocytogenes.* Hence meat product category of samples is the higeshest contaminated category of food samples.

In fruit and vegetables category of samples, highest plate count is in FV-1(139x10^{5} cfu/gm), highest coliform count is in sample Fv-2(136 cfu/gm) and highest *S.aureus* count is 120 in

Table 1: Microbiological analysis of different categories of food.

Category	Sample No.	Total plate count	Coliforms	Staphylococcus aureus	*Bacillus cereus*	Salmonella	*Shigella*	Vibrio cholerae	Listeria monocytogenes
Dairy and milk products	DM-1	215 x10^4cfu/g	145 cfu/g	120 cfu/g	56 cfu/g	**Present/25gm**	Absent/ 25g	Absent/ 25g	**Present/25gm**
	DM-2	186 x10^4cfu/g	172 cfu/g	132 cfu/g	40 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	DM-3	58 x 10^3cfu/g	159 cfu/g	128 cfu/g	90 cfu/g	**Present/25gm**	**Present/25gm**	Absent/ 25g	Absent/ 25g
	DM-4	134 x 10^3cfu/g	145 cfu/g	124 cfu/g	40 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	DM-5	180 x10^3cfu/g	165 cfu/g	226 cfu/g	58 cfu/g	**Present/25gm**	Absent/ 25g	Absent/ 25g	Absent/ 25g
	DM-6	55 x10^3cfu/g	170 cfu/g	202 cfu/g	47 cfu/g	**Present/25gm**	**Present/25gm**	Absent/ 25g	**Present/25gm**
	DM-7	179 x10^3cfu/g	149 cfu/g	175 cfu/g	92 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	DM-8	52 x10^3cfu/g	176 cfu/g	156 cfu/g	48 cfu/g	**Present/25gm**	**Present/25gm**	Absent/ 25g	Absent/ 25g
	DM-9	66x10^3cfu/g	158 cfu/g	135 cfu/g	59 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	DM-10	176 x 10^2 cfu/g	80 cfu/g	218 cfu/g	30 cfu/g	**Present/25gm**	**Present/25gm**	Absent/ 25g	**Present/25gm**
Ready to eat foods	RTE-1	204 x 10^2 cfu/g	< 10 cfu/g	20 cfu/g	132 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	RTE-2	162 x 10^2 cfu/g	50 cfu/g	28 cfu/g	105 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	RTE-3	191 x 10^2 cfu/g	20 cfu/g	35 cfu/g	85 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	RTE-4	218 x 10^2 cfu/g	< 10 cfu/g	45 cfu/g	69 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	RTE-5	179 x 10^2 cfu/g	70 cfu/g	42 cfu/g	45 cfu/g	**Present/25gm**	Absent/ 25g	Absent/ 25g	Absent/ 25g
	RTE-6	178 x 10^2 cfu/g	60 cfu/g	47 cfu/g	32 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	RTE-7	185x 10^3 cfu/g	45 cfu/g	58 cfu/g	78 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	RTE-8	215 x10^3cfu/g	30 cfu/g	67 cfu/g	85 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	RTE-9	205 x 10^2 cfu/g	55 cfu/g	51 cfu/g	69 cfu/g	**Present/25gm**	**Present/25gm**	Absent/ 25g	Absent/ 25g
	RTE-10	196 x 10^2 cfu/g	72 cfu/g	54cfu/g	102 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
Meat products	M-1	99 x 10^4 cfu/g	627 cfu/g	208 cfu/g	92 cfu/g	**Present/25gm**	**Present/25gm**	Absent/ 25g	**Present/25gm**
	M-2	182 x 10^3cfu/g	536 cfu/g	185 cfu/g	98 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	M-3	52 x 10^4 cfu/g	1600 cfu/g	172cfu/g	85 cfu/g	**Present/25gm**	-do-	Absent/ 25g	**Present/25gm**
	M-4	85 x 10^2 cfu/g	400 cfu/g	145 cfu/g	79 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	**Present/25gm**
	M-5	125 x 10^2 cfu/g	204 cfu/g	138 cfu/g	102 cfu/g	**Present/25gm**	Absent/ 25g	Absent/ 25g	**Present/25gm**
	M-6	215 x10^3cfu/g	210 cfu/g	205 cfu/g	82 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	M-7	125 x10^3cfu/g	305 cfu/g	215 cfu/g	98 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	M-8	178 x10^3cfu/g	214 cfu/g	94 cfu/g	89 cfu/g	**Present/25g**	**Present/2**	Absent/	**Present/25gm**

						m	**5gm**	25g	
	M-9	185 x10^3cfu/g	282 cfu/g	67 cfu/g	79 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	M-10	220 x10^3cfu/g	198 cfu/g	62 cfu/g	102 cfu/g	**Present/25g m**	Absent/ 25g	Absent/ 25g	**Present/25gm**
Fruits & Vegetables	FV-1	139 x 10^5 cfu/g	118 cfu/g	20 cfu/g	< 10 cfu/g	**Present/25g m**	Absent/ 25g	Absent/ 25g	Absent/ 25g
	FV-2	100 x 10^4 cfu/g	136 cfu/g	56 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	FV-3	148 x 10^3 cfu/g	90 cfu/g	58 cfu/g	< 10 cfu/g	**Present/25g m**	Absent/ 25g	Absent/ 25g	Absent/ 25g
	FV-4	63 x 10^5 cfu/g	114 cfu/g	54cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	FV-5	116 x 10^5 cfu/g	80 cfu/g	70 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	FV-6	45 x 10^5 cfu/g	85cfu/g	102 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	FV-7	98 x 10^4 cfu/g	70 cfu/g	110 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	FV-8	70x 10^4 cfu/g	62 cfu/g	58 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	FV-9	75 x 10^4 cfu/g	79 cfu/g	120 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	FV-10	62 x 10^4 cfu/g	92 cfu/g	74 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
Cereal & Pulses	CP-1	98 x 10^3 cfu/g	50 cfu/g	40 cfu/g	< 10 cfu/g	**Present/25g m**	Absent/ 25g	Absent/ 25g	Absent/ 25g
	CP-2	54 x 10^3 cfu/g	76 cfu/g	43 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	CP-3	50 x 10^3 cfu/g	55 cfu/g	65 cfu/g	< 10 cfu/g	**Present/25g m**	Absent/ 25g	Absent/ 25g	Absent/ 25g
	CP-4	74 x 10^3 cfu/g	72 cfu/g	55 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	CP-5	63 x 10^3 cfu/g	79 cfu/g	59 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	CP-6	60 x 10^3 cfu/g	85cfu/g	62 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	CP-7	80 x 10^3 cfu/g	90 cfu/g	58 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	CP-8	50 x 10^3 cfu/g	72 cfu/g	52 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	CP-9	43 x 10^3 cfu/g	78 cfu/g	43 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g
	CP-10	42 x 10^3 cfu/g	90 cfu/g	42 cfu/g	< 10 cfu/g	Absent/ 25g	Absent/ 25g	Absent/ 25g	Absent/ 25g

sample FV-9. *B.cereus* is not detected in any fruit and vegetable sample. *Vibrio cholera, Shigella* and *Listeria monocytogenes* also not detected in all selected samples of fruit and vegetables. Only two samples FV-1 and FV-3 are positive for *Salmonella.* Hence, we can say that fruit and vegetables samples selected were not too much contaminated as compare to samples of other categories.In cereal and pulses category selected for analysis, highest plate count is in sample CP-1($98x10^{3)}$ cfu/gm, highest *S.aureus* count is 65 cfu/gm in sample CP-3.All samples of cereal and pulses are negative for Vibrio cholera, Shigella and Listeria monocytogenes and only two samples CP-1, CP-3 are positive for Salmonella.

In the light of results obtained after analysis of all food and vegetable samples, we can say that fruit and vegetable category and cereal and pulses category are less contaminated as compare to other food categories selected for analysis.

6. IMPACTS OF MICROBIAL CONTAMINATION OF FOOD

The microbiological contamination of food has very potential impacts which can be devastating for our society where we are living. Health impact of microbiological contamination of food is most important as it is the only which may lead to a wide range of health problems. Food-containing harmful microorganisms are responsible for more than 200 diseases ranging from diarrhea to cancers [1]. Many kinds of infections such as fever, vomiting, weakness, chills and aches, headaches, abdominal pain, constipation, throat infection, muscle paralysis can also result from the consumption of foods contaminated by microbial pathogens. As it is evident from the results in **table-1** that all kinds of samples were higly contaminated with food borne pathogens such as *Salmonella*, *Shigella*, *Listeria*. The diseases caused by pathogens found in foods under study can be hemorrhagic colitis, diarrhea, vomiting, cholera, typhoid, listeriosis, gastroenteritis, abdominal pain. Sometimes major complications such as septicemia, bacteremia, reactive arthritis, localized infection of few organs like cirrhosis of liver are the most severe illnesses associated with microbial contamination of food. According to Lindsay, an estimated 2.3 percent of all acute foodborne illnesses develop secondary long-term illnesses and complications (called chronic sequellae which can occur in any part of the body including the joints, nervous system, kidneys or heart) that may become chronic health problems [15]. The impact of food borne diseases caused by microbial contamination of food can be life threatening for young children, pregnant women and their fetuses, the elderly and people with compromised immune systems. According to Crutchfield and Roberts (2000), food-borne illness imposes substantial economic costs on society [20].Impacts of Microbiological Contamination Of Food may also includes supply of unsafe food product, Loss of consumers‘confidence and loyalty, . Loss of food industry‘s reputation and Discontinuation of food business (closing of business).

7. PREVENTION AND CONTROL OF MICROBIOLOGICAL CONTAMINATION OF FOOD

Microbiological food safety , the control of food microbial contamination and the consequent impacts must take place from the primary production to the dining table since the general food produce and animal production practices, general food housekeeping, food handling, preparation facilities, conditions of cooking utensils and food contact surfaces, dishwashing and serving practices, food storage system as well as food handlers knowledge and practices affect food safety directly or indirectly. Food safety education for consumers and staff in the food industry is integral to prevention of food contamination and its consequences. The identification of contaminants and the primary infection sources and their importance permits a targeted and efficient prevention and control. Spreading information and knowledge about the sources and routes of transmission of pathogens into food protects food from contamination and a population from food borne disease [17]. Following of good agricultural practices (GAP) during pre-harvesting can also help in reduction of microbial contamination of food and thus increase substantially, food safety and shelf life of food. Good Hygienic, Good Manufacturing, Good Distribution and Good Storage practices are key factors in preventing microbiological contamination of food at postharvest [21

Adequate knowledge of proper handling, storage and preservation of food can be helpful in minimizing microbial contamination and health related issues associated with foods During distribution and storage of different kinds of food such as raw meat, dairy and poultry products, ready to eat products should be separated from other kinds of foods, because bacteria can multiply rapidly on prepared leftover and spoiled dairy foods, meats and poultry products left at room temperature.

8. CONCLUSION

A food that is safe and free from contamination and spoilage at all points in its journey from its source to consumers is the basic need. As evident from the results that food samples selected for analysis were highly contaminated with food borne pathogens. In results under study, almost all samples were found contaminated with pathogens such as *Salmonella*, *Shigella* and *Listeria* but dairy and milk products and meat products category of foods were highly contaminated as compare to other categories of food selected for analysis. In view of the above, it is found that highly contaminated food with food borne pathogens is being sold if food selling stores. There is evidence that no nation, whether developed or not is free from the health impact of microbiological contamination of food. Every year in the world, most of the people die from food borne diseases resulting from microbial contamination of food. In 1999, an estimated 5,000 deaths, 325,000 hospitalizations and 76 million illnesses were caused by food borne illnesses within the US [13]. In 2014, there were more than 100, 000 cases of cholera in 22 countries resulting in over 1700 deaths. So far 2015, cholera outbreaks in 13 countries have led to over 200 deaths out of more than 13,000 cases [25].Health department is not having regular check on food items to ensure sale of safe food free from pathogens. Control of microbial contamination of food items should be started from primary production so that final supply is free from these contaminants. Much improvements in hygienic working practices of maintenance personnel in food industry is required to minimize the occurrence of diseases associated with microbial contamination of food. Perishables food items such as eggs and meat products which can harbor salmonella frequently, should be stored below 400F to decrease contamination. It is not possible that only health department can prevent the contaminations of food be framing rules and regulations. There should be strict follow up of

rules meant for food safety. One way to save people from all the detrimental impacts of microbiological contamination is to spread information and knowledge about the sources and routes of transmission of pathogens into food. The precautionary measures such as Good Agricultural Practices, Good Manufacturing Practices, Good Hygienic Practices, Good Transportation Practices, and Good Storage Practices can be helpful to minimize microbial food safety hazards. To ensure supply of safe food for the nation, there is need to understand routes of food contamination, Impacts of pathogen on food and to follow the strict food safety rules to avoid food contamination with food borne pathogens.

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