

# Microbial Infections Transmission through Meat Intake in Pakistan

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## Abstract

Meat is one of the most consuming food items around the globe and also serves as vector for broad spectrum foodborne diseases. The occurrence of such ailments in developed countries is lower than the developed countries where overall conditions are not hygienic and up to the mark, from animal farming to meat processing and packing level. Likewise, in Pakistan, although poultry, dairy farming and fisheries departments are much established still improper slaughtering and meat handling, inappropriate ways of preservation and cooking along with poor shelf life are major issues. Parallel to these, lack of dose optimization either of vaccines and antibiotics also affect the meat quality. That's why; implementation of preventive measures regarding animals and their meat handling and its preservation should be ensured. This target can be achieved by spreading general public awareness. In future, researchers should try to introduce such cost effective ways and methods which facilitate the farmers and other economically constraints facing people and also professional training sessions should be offered to those who are usually involved in poultry, animal and fish farming, meat handling, processing and transportation.

**Keywords:** Meat; foodborne diseases; meat processing; dose optimization; meat handling; public awareness .

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## 1. Introduction

Meat obtained from animals is consumed as food. The word meat is characteristically employed for the flesh of mammalian species (for example steers, sheep, dairy animals and sheep) but currently, chicken and fish are also categorized in this general term. Meat is believed to be as the side-products of dairy industry. In Pakistan and farm house owners try their best to get maximum meat production along with good quality dairy products [1, 2]. For the betterment of meat production and animal farming, professionals are working on improved provision of water and balanced diet [3]. Among animal based foods, meat is considered as profoundly nutritious and due to rich source of important proteins, nutrients, minerals, micronutrients and fats so it is a significant part of human diet [4]. There are ten basic food supplements which are obtained from meat i.e. vitamin A, vitamin B1, vitamin B2, vitamin B6, vitamin B12, iron, zinc, niacin and considerable amount of protein and energy [2]. It also contains omega 3 fatty acids and conjugated linoleic acids which are also essential for good human health [4]. Moreover, poultry industry of Pakistan has expanded its production rate from 20% to 25% per annum to provide meat 0.652 million tons that is 23% of the all-out meat production at national level [5]. Poultry production is directly influenced by farm size which may range from <1,000 to  $\geq 10,000$ . For example, only Khushab (district of Punjab) has 7.4 million ovens, 0.20 million layers, 0.08 million broilers, and 0.28 million poultry production at provincial level [6]. In current review, authors have tried to highlight all those factors which influence either directly or indirectly dietary meat quality and make it a significant vector of broad spectrum microbes.

## 2. Food as microbial transmitter

They may be divided into following:

### 2.1 Chicken based microbes

Globally, chicken based food items have higher consumption rate and they are also related with the ailments. In this regard, two fundamental pathogens causing foodborne ailments are *Staphylococcus aureus* and *Bacillus cereus* are significant [5]. The major poultry ailments include: Newcastle ailment, *Escherichia coli* contamination, Infectious coryza, Infectious bronchitis, Coccidiosis, Enteritis, Fowl pox, Salmonellosis, Hydropericardium disorder (HPS), and Avian Influenza. The country wide poultry disorders spread due to poor immunization, substandard feed, lodging, and through transitory flying creatures [6]. Backyard poultry is one of the major reasons of transmission of diseases because it is the source of the earliest stage parasitic oocysts shedding by the felines [7]. Seasonal changes may exploit poultry sicknesses [6]. Yeast and molds are also a leading factor of meat spoilage. These attacking microbes continuously rot and induce their mycotoxins in meat and its products which further may impair liver and contaminate food [5]. Chicken meat is the most commonly consumed food in Pakistan and is one of the major sources of spread of multi-drug resistant (MDR) *E. coli*. These harmful bacteria can survive both in cooked and raw meat. It commonly causes urinary tract infection, bloodstream infections, pneumonia, post-surgical infections and intra-abdominal infections. Herbs are used to treat various infectious diseases worldwide [13].

### **2.1. Fish based microbes**

Fish is form of digestible white meat, rich in organic nourishment and unsaturated fats. It is also essential for ideal growth of cerebrum in babies and infants [8, 9]. But due to the presence of higher water content along with protein compound, fish is much prone to pathogenic microbial attack, for example, *Salmonella* spp., *Vibrio parahaemolyticus*, *Escherichia coli*, *Staphylococcus aureus*, and *Aeromonas* spp., which are naturally abundant in its habitat [10,11]. Moreover, *V. parahaemolyticus* dweller of marine environment and attacks on vast range of fishes. That is why; it is perceived as the main source of human gastroenteritis is the intake of crude fish utilization or inappropriately cooked shellfish [12].

### **2.2. Camel meat based microbes**

According to reported data, Pakistan has approx. 1 million camels and it is largest population on the planet. Camel meat does not have much higher content of cholesterol and fat like beef [17]. But camel meat is the most potent dietary source of toxoplasmosis transmission in humans. Its causative agent is *Toxoplasma gondii* which parasitizes diverse warm blooded animals, specifically birds. Around 500 million people per year are found to have antibodies against *T. gondii* disease. Other sources of transmission are: the ingestion of water, food items contaminated by feline dung, crude or half-cooked meat [18].

### **2.3. Beef based microbes**

Buffaloes (*Bubalus bubalis*) are important ruminants and major source of milk, meat and of compost in developing Asian countries. Wild ox meat has been additionally found a good source of nutritious meat as it exhibits better natural defense system of body, the capacity to adjust in different climatic conditions, enhanced growth rate and body weight which show their flexibility and ability that are ideal for farming [19]. Moreover, due to the 1.7 million tons per year beef consumption in Pakistan, it is ranked 9th among beef consuming nations [14]. So it may transmit various pathogens, if not cooked properly. In this regard, antibiotics are used for the treatment and to improve the animal meat production [15]. But these antibiotics raise public health issues like hypersensitivity, tissue damage, gastrointestinal disturbance and bacterial resistant strain [16].

## **3. Major reasons of dietary meat contamination**

Following are the common reasons of meat and poultry contamination in Pakistan and other third world countries:

- Inappropriate conditions of butcher shop
- Stockpiling (raw meat is stored in retail shops without \temperature control units)
- Poor transportation
- Improper handling of meat and poultry
- Unhygienic conditions which are ideal for different microbial and microscopic pathogens [20]
- Untidy freezing units [21]

**Table 1:** Major microbial foodborne diseases and their clinical features in developed countries (FDA, 2012; WHO, 2008a) [29]

Microbes	Sickness	Signs & Symptoms	Dietary route of transmission
<i>Aeromonas hydrophilia</i>	<i>Aeromonas enteritis</i>	Blood and mucus in the stool, abdominal cramps, mild fever, vomiting	Seafood (fish, shrimp, oysters), snails, meats (beef, pork, lamb, and poultry)
<i>Bacillus cereus</i>	<i>B. cereus</i> gastroenteritis	Abdominal cramps, watery diarrhea, nausea, vomiting, and pain	Meats (beef, pork, lamb and poultry)
<i>Campylobacter sp.</i>	Campylobacteriosis	Bloody diarrhea, abdominal cramps, fever, vomiting, nausea, headache, and muscle pain	Raw and undercooked poultry, beef, pork and seafood [22-28]
<i>Salmonella spp.</i>	Salmonellosis	Diarrhea, fever, vomiting, nausea, headache	Poultry and meat
<i>E. coli</i>	<i>E. coli</i> infection	Abdominal cramps, vomiting, high fever, nausea	Raw or undercooked ground-meat products [23]
<i>Vibrio parahaemolyticus</i>	<i>V. parahaemolyticus</i> gastroenteritis	Watery and/or bloody diarrhea, abdominal cramps, nausea, vomiting, fever	Undercooked or raw seafood, such as shellfish, raw or undercooked fish and fishery products, raw or improperly cooked oysters, other seafood products, including finfish, squid, octopus, lobster, shrimp, crab, and clams
<i>Staphylococcus aureus</i>	<i>Staphylococcus aureus</i> intoxication	Severe nausea, vomiting, abdominal cramps, diarrhea, dehydration, headache, muscle cramping, and transient changes in blood pressure and pulse rate	Unrefrigerated or improperly refrigerated meats and meat products, poultry, tuna and chicken
<i>Streptococcus spp.</i>	<i>Streptococcus spp.</i> intoxication	High fever, headache, nausea and vomiting	Improper cooked seafood and shrimp
<i>Vibrio cholerae</i>	Cholera	Profuse watery diarrhea, severe dehydration, abdominal pain and vomiting,	Seafood, Mollusca shellfish (oysters, mussels, and clams), crab, lobster, shrimp and squid
<i>Yersinia enterocolitica</i>	Yersiniosis	Abdominal pain, diarrhea, mild fever, sometimes vomiting	Meats (pork, beef, lamb, etc.), oysters, fish and crabs

#### 4. Routes of meat based diseases

There are numerous factors due to which organisms or pathogens transmitted to meat and cause broad spectrum disorders. As foodborne illnesses results due to consumption of unhygienic food items. Contamination of the meat at any stage, from generation to utilization, induces microbial infections and accumulation of their toxins which are basically in the long run reason of the foodborne sicknesses [30]. Major causes of dietary meat products' contamination are follows:

##### 4.1 Improper cooking

Improper handling of semi-cooked/ cooked meat products or even their repeated warming and to hold them up in the warmth, poor cleanliness and the re-utilization of remains, result in 44% of the foodborne sicknesses.

Overall this poor management also allows the exposure of cross-pollution to food and causes 14% of ailments which are transmitted through meat based products [30].

#### ***4.2 Antimicrobial residues***

The remains of different injected vaccines and antibiotics are also sometimes found in animals' tissues (meat) and subsequently enter the human body [31]. The presence of these anti-toxins in beef and other forms of meat is related with a few general unfriendly wellbeing impacts including weak immune system, tissue damage and gastrointestinal disturbance [32].

#### ***4.3 Improper handling***

Microbial exposure in chicken often occurs due to inappropriate preparation and handling, washing with contaminated water, bundling, deboning, and might be because of flies, dust, equipment's and temperature variation of storage units and transportation [33, 34]. The transportation of fishes in tainted containers and washing of fish meat with e.g., lake water may likewise prompt bad aquatic conditions and food contamination. [36].

#### ***4.4 lack of personal hygiene***

Reported data have demonstrates that due to the lack of personal hygiene among meat laborers and handlers is a potent source of foodborne ailments so appropriate hand washing and other hygienic practices should be implemented to reduce this risk. The current unhygienic practice might be significant promoting factor of cross-contamination and for spread of foodborne illness. Review of published data indicates that up to 60% meat handlers don't follow hygienic methods. Similarly, 25 to 40 working staff of meat processing organizations has also been found to follow poor hygienic practices [30].

#### ***4.5 Improper temperature***

For export and to maintain meat quality for longer use meat is stored and preserved. Various investigations indicate that preserved meat quality varies due to the temperature of freezer and freezing rate. If the meat is not frozen properly for long storage then it may serve as an ideal substrate for microbial growth and proliferation and its consumption will induce broad spectrum ailments. For instance, the routinely used fare stockpiling temperature (- 18°C) has been found to keep up adequate quality and avoid spoilage of sheep's meat for one year yet. Thus this temperature is sometimes not ideal for meat preservation [35-37].

### **5. Dietary meat associated microbial infections in Pakistan**

#### ***5.1 Campylobacteriosis***

*Campylobacter* contamination (commonly known as Campylobacteriosis) is a worldwide and growing form of zoonosis. *Campylobacter* is thermostable pathogen which causes gastroenteritis along with disturbed bowel. The

root cause of this issue is tainted food items including crude meat, of meat items, and intake of contaminated water even of non-boiled milk. Additionally, slicing boards, blades and hands of meat handlers contribute significantly in the transmission of Campylobacteriosis [38].

### **5.2 Prostate malignant**

Prostate malignant growth is the fourth major disease irrespective of genders and the second most common disease in males. Elevated consumption of lipids rich food, particularly red meat and dairy items straightforwardly increase the chances of prostate malignancy [39].

### **5.3 Salmonellosis**

Fishes serves as roughly 17% of dietary protein source. Salmonellosis is a second leading reason of foodborne ailment at global level. Fishes are considered as ideal host of various pathogens like *Salmonella*. Moreover, smoked fishes serve vector for the transmission of *Salmonella* that exists on skin, in gills and digestive tract. This pathogen causes gastroenteritis, stomach issues, enteric fever and bacteremia significantly in summer season due to ingestion of uncooked/semi fishes [40].

## **6. Preventive measures and control**

Following preventive measures should be adopted to control microbial infection related to dietary meat:

### **6.1 Awareness of poultry farmers**

Training sessions of poultry farmers should be organized to make them aware about the preventive measures and chicken vaccination and antibiotics induction methods, in return, to obtain accelerated rate of feed absorption by chicken and to reduce mortality ratio. In time inoculation considerably minimizes the risk of pathogenic attack for longer duration. During awareness sessions, such useful vaccinations may be introduced among poultry handlers. But reported data also elaborate that these pathogenic strains may exhibit genetic mutations and develop resistance against given antibiotics and in such conditions, control of pathogens become difficult. Moreover, published data also support that the exposure of heat during cooking process may significantly reduce broad spectrum pathogens [41].

### **6.2 Farm management**

First of all, veterinarians should identify optimized dose of antibiotics to get targeted results. The lack of prescribed dose of these shots can prompt more health risks among farmed animals. That is why; the farmers should be aware of losses due to induction of over/low dosage which indirectly affect the health of consumers (humans/animals), in this way, they will apply only the optimized dose. Similarly, the implication of antibiotics as growth promoters or for any other purpose should be minimized by following good farm management practices and providing a hygienic environment to animals [41].

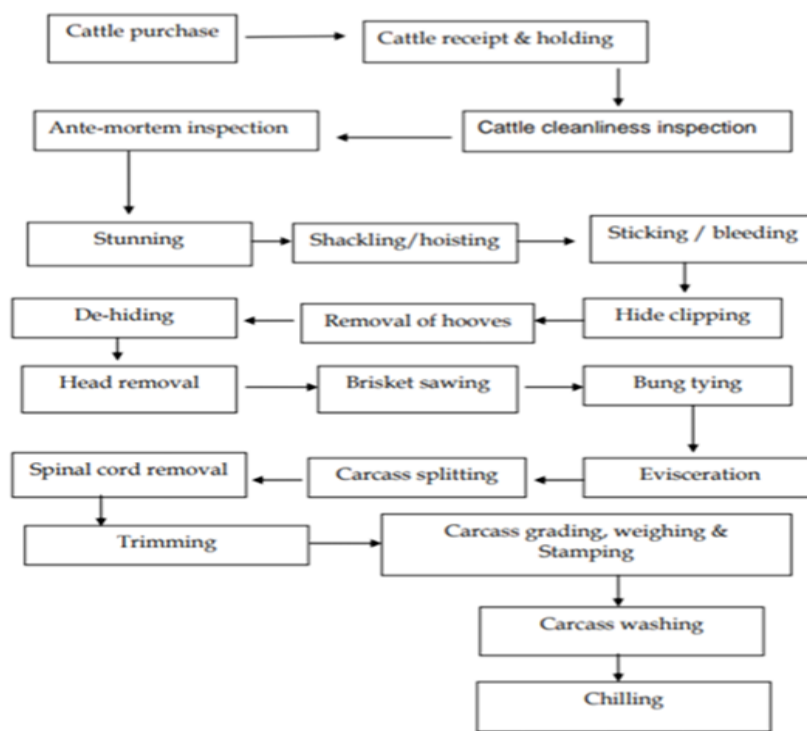
### 6.3 Public awareness

General public awareness campaigns about proper use of antibiotics should be arranged for poultry and dairy farmers and other public so that the frequently reported antibiotic resistance issues should be resolved [42].

### 6.4 Proper fishes' cooking

Reported data indicates that fishes of polluted stream/lakes contain *Salmonella* and their intake is a source of disease transmission. The amount of contaminated fishes is increasing in different endemic water bodies due to interventions of human like addition of effluents and poultry farms' waste. Thus a general mass awareness regarding harms of crude or inappropriately cooked consumption of fish is required. Quality control measures should be adopted either at commercial or domestic level of fish consumption and only recommended meat should be consumed. *Salmonella* surveillance in edible fishes is an indication that effective control and preventive measures are needed against this zoonotic pathogen [43].

### 6.5 Up-to-date slaughter system



**Figure 1:** Flow chart presenting protocol of beef slaughter and meat processing [47]

In Pakistan, traditional animals' slaughtering methods are in practice to get meat, is a foremost cause of dietary meat contamination which leads to intestinal infections. The major root causes of the lack of proper butchering framework so far are that slaughter houses and other meat enterprises offer low income packages and hire untrained staff that is ignorant about sanitation and food hygiene. In this regard, Public and private sector organizations have initiated such programs and campaigns to replace traditional butchering framework to

current up to date system, to ensure hygienic meat provision to masses (Figure1) to reduce the prevalence of meat intake based ailments [38].

### **6.6 Meat irradiation technology**

Food/meat irradiation is an innovation and introduced by Nuclear Institute of Food and Agriculture, Peshawar which is gaining global acknowledgment. In its application, meat is exposed to ionic radiations to inhibit microorganisms and improves itself life. The way public awareness about sanitation is improving gradually, various methodologies are in application e.g., gamma rays of microwave, light and cold purification [44].

### **6.7 Management of slaughterhouse**

In Pakistan, 370000/year animals are slaughtered which are generally exchanged among different purchasers of live stock market. During it, because of the lack of awareness regarding food safety, are handled unhygienically. So the best possible administration of animal farming and meat handling is required for the safety of health and for maintaining the quality of meat and meat based products for long time period [45].

### **6.8 Facilities of slaughterhouse**

According to hazard analysis and critical control points' principles (HACCP), following facilities should be provided in slaughterhouse and meat processing center. These are:

- Quarantine offices
- Post mortem assessment of body
- Facilities for cleansing of different mechanical gears
- Sufficient number of rooms
- Adequate lairage Proper Washing offices
- Proper Drainage framework
- Waste administration framework
- Preservation offices
- Chilling offices [46]

### **6.9 Poultry pest control**

House fly (*Musca domestica*) serves as an important vector of poultry for transmission of more than 100 pathogens like protozoan, bacteria, helminthes and viruses. Moreover, this fly also transmits causative agents of zoonotic sicknesses of poultry e.g., *Campylobacter*, *Salmonella* and avian flu. In poultry farms birds' droppings which have significant moisture content and ideal temperature conditions for propagation of *M. domestica*. Raised population of house fly affects severely not only to poultry workers but also to hens and results in reduction of estimated poultry production. So in this regard, effective controlling measures should be implemented [47].



### 6.10 Natural preservatives for meat

Minced meat is commonly more consumed form so to improve its shelf life various artificial preservatives and additives are in practice which indirectly affects health of consumers. Thus they should be replaced by harmless floral extracts like *Moringa oleifera* and *Brassica oleracea* [48].

### 7. Conclusion and future perspective

Microbial contamination of dietary meat is not only causes direct/indirect economic losses like declining profitability, animal populations' reduction and their farming costs but major concern is risk to human health. Currently, researchers are trying to explore better and improved ways of hygienic conditions for the dietary meat preservation, control of zoonosis and its better shelf life for consumers. Like developed countries, in third world countries e.g. in Pakistan, before slaughtering, animals should be inspected first, properly vaccinated and placed in physically sterilized conditions. In this regard, general public awareness campaigns should be organized to improve overall view of people about significance of hygiene [49]. Similarly, better ways should be introduced for the preparation of meat based produce and for their enhanced shelf life [47].

### 8. Recommendation

Future researchers should be focused on vaccination and drugs dose optimization for animals from which meat is obtained [41]. Basically crude meat level is the point of onset of majority diseases than its further handling and transport. That's why; hygiene and other related preventive measures should be ensured during slaughtering, preparation, drying, packing, and drug and vaccine inoculation and for improved shelf life to protect the consumers [42, 50].

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