Overview of Microbial Food Safety Issues: Meat and Poultry Products

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Division Of Veterinary Public Health
Indian Veterinary Research Institute
Izatnagar
- Indian Meat & Poultry Industry
- Important Foodborne Pathogens
  - Bacterial, Viral, Parasitic
- Other Microbial Food Safety Issues
  - Trans-boundary animal diseases
  - Increasing antibiotic resistance
  - Foodborne surveillance
  - Risk assessment and standards
- Strengths/ Advantages
Indian Meat Industry

- Meat production: 6.4 Million Tonnes
- Value of meat produced: Rs.21,900 crores
- Meat products: Rs.828 crores
- Registered slaughter houses: 3900
- Unregistered slaughter houses: 25750
- Modern Integrated meat plants: 15
- 15 more coming in near future

Export

- Buffalo meat: 4,94,111.48 MT
  - Value of Rs. 3,211.70 Crores
- Sheep/goat meat: 5,481.55 MT
  - Value of Rs. 63.05 Crores

(2006-07)

- Bovine meat: 97% contribution

Source: APEDA web site
Indian Poultry Industry

- Transformed from backyard to a well-organized industry
- 70%: organized sector & 30%: unorganized sector
- Contribution: 11,000 crores to National GDP
- Egg production: 45.2 billion eggs (4th in world)
- Broiler production: 2.0 million tonnes (19th)
- Poultry products export: Rs. 315.90 Crores (2006-07)

Food Safety

- Increased global trade
- Discerning and knowledgeable consumer

Important issue

- BSE & nv CJD: UK
- Melamine in milk/milk products: China
- Pesticide residues in cold-drinks: India
- Avian Influenza: India and Asian countries
Microbial Food Safety

- Foodborne illness: Global magnitude difficult to assess
  - Deaths due to diarrhoeal diseases in 2005: 1.8 million
  - Developed countries: 30% population (INFOSAN WHO 2008)
- USA: 76 million cases of foodborne diseases
  - 325,000 hospitalizations
  - 5,000 deaths
- India: Magnitude is unknown
  - Diarrhoeal diseases (Food and waterborne): 18.6 million children under age of 5
  - 3,86,000 deaths in children (1 in every 5 global deaths in children)
Transmission of Foodborne Diseases

- Animal feed/environment/protozoans
  - Food animals
    - Manure
      - Animal derived food products
      - Plant derived products
        - Food Processing Plants
          - RTE Foods
            - Humans
Important Pathogens
<table>
<thead>
<tr>
<th>Point</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2541 serotypes</td>
<td></td>
</tr>
<tr>
<td>&gt; 128 serotypes present in India</td>
<td></td>
</tr>
<tr>
<td>New added every year</td>
<td></td>
</tr>
<tr>
<td>Prevalence in human (non typhoid): 1 - 5%</td>
<td></td>
</tr>
<tr>
<td>Prevalence in healthy carriers: 1 - 2%</td>
<td></td>
</tr>
<tr>
<td>Prevalence in meat and poultry: 5 - 7%</td>
<td></td>
</tr>
<tr>
<td>RTE meats and poultry products: 0 - 3%</td>
<td></td>
</tr>
</tbody>
</table>
Zoonotic *Salmonella* serovars in animals

Singh, 2004

- S. Typhimurium: 14%
- S. Virchow: 10%
- S. Enteritidis: 5%
- S. Weltevreden: 5%
- S. 3,10:12:-: 4%
- S. Bareilly: 3%
- S. Anatum: 3%
- Others (75 serovars): 56%
Salmonella serovars in buffaloes

- **Anatum**: 45%
- **Weltevreden**: 20%
- **Typhimurium**: 8%
- **Bareilly**: 2%
- **Dublin**: 2%
- **Lagos**: 3%
- **Orion**: 3%
- **Saintpaul**: 5%
- **4,12:i:-**: 2%
- **Rough**: 8%

 установленных автором авторскими правами и условиями использования и распространения.
Salmonella serovars in Cattle

Typhimurium 25%

Dublin 29%

Rough 9%

Drogana 3%

Chester 6%

Enteritidis 4%

Havana 3%

Saintpaul 1%

Muenchen 1%

Rostock 1%

Paratyphi B 1%

Mbandaka 4%

3,10 : r : - 1%

Heidelberg 1%

Weltevreden 1%

Typhimurium var copenhagan 1%

Adelaide 1%

Anatum 1%

Berta 1%

Singh, 2004
Salmonella serovars in Goats

- Rough: 22%
- Bareilly: 3%
- Dublin: 4%
- 28 : b : enx: 5%
- Infantis: 4%
- Paratyphi B: 5%
- Saintpaul: 3%
- Stanley: 3%
- Other 27 serovars: 24%
- Weltevreden: 9%
- Virchow: 7%
- Typhimurium: 11%

Singh, 2004
Salmonella serovars in birds

Singh, 2004

- Virchow and Typhimurium are more common than Enteritidis.
- One of the most common pathogen
- Different types
  - EPEC
  - ETEC
  - EIEC
  - EAggEC
  - EHEC
  - DAEC
  - CDTEC

Frequently reported
Several isolations in recent times
Prevalence in Meats

- Numerous reports
  - Meat and poultry products: 20-50%; up to 100%
  - Human diarrhoea
  - Animal diarrhoea

- STEC (EHEC): Isolations in recent years
  - Animals: Important reservoirs
  - Isolations from meats: Buffalo, sheep, goat, kebabs, sausages
  - Majority STEC are non O 157: H 7
  - O 157: H 7: Rare
## Prevalence of STEC in Human

<table>
<thead>
<tr>
<th>Source</th>
<th>No. of <em>E. coli</em></th>
<th>STEC</th>
<th>Place</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhoeal patients</td>
<td>1338</td>
<td>9</td>
<td>New Delhi</td>
<td>Pamchandran and Verghese (1987)</td>
</tr>
<tr>
<td>HUS patients</td>
<td>25</td>
<td>19</td>
<td>New Delhi</td>
<td>Kishore <em>et al.</em>, (1992)</td>
</tr>
</tbody>
</table>
L. monocytogenes

- Meningo-encephalitis & abortion
- Grows well: Refrigeration temperature
- Grows: Moderately low pH
  High salt concentration
- Survives and can multiply under diverse environmental conditions
  Various stages of production, processing and storage
  - Biofilm production
### Prevalence in Meats

<table>
<thead>
<tr>
<th>Source</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Buffalo meat</td>
<td>&lt; 10%</td>
<td>Gujarat</td>
<td>Brahmbhatt and Anjaria (1993)</td>
</tr>
<tr>
<td>Goat meat</td>
<td>&lt; 10%</td>
<td>Bareilly</td>
<td>Banurekha et al., (1998)</td>
</tr>
<tr>
<td>Goat meat</td>
<td>6.66%</td>
<td>Bareilly</td>
<td>Barbuddhe et al., (2000)</td>
</tr>
<tr>
<td>Sheep meat</td>
<td>7.4%</td>
<td>Bareilly</td>
<td>Barbuddhe et al., (2000)</td>
</tr>
<tr>
<td>Various meats products</td>
<td>3 - 8%</td>
<td>Bombay</td>
<td>Waskar (2005)</td>
</tr>
<tr>
<td>Poultry meat</td>
<td>8.5%</td>
<td>Nagpur</td>
<td>Kalorey et al., (2005)</td>
</tr>
</tbody>
</table>
## Prevalence in Human

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<th>Source</th>
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<th>Place</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abortion (150 patients)</td>
<td>14%</td>
<td>Mumbai</td>
<td>Krishna et al., (1966)</td>
</tr>
<tr>
<td>Abortion still births</td>
<td>3%</td>
<td>-</td>
<td>Bhujwala et al., (1973)</td>
</tr>
<tr>
<td>Abortion</td>
<td>3.3%</td>
<td>Northern India</td>
<td>Kaur et al., (2007)</td>
</tr>
<tr>
<td>Abortion</td>
<td>10%</td>
<td>Nagpur</td>
<td>Kalorey (2008)</td>
</tr>
<tr>
<td>Abortion</td>
<td>6%</td>
<td>Goa</td>
<td>Barbuddhde (2008)</td>
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</table>
Campylobacter

- Important diarrhoeal pathogen
  - Guillain-Barré Syndrome

- Human diarrhoea: 10 - 15%
- Many asymptomatic carriers

- Poultry: Most important transmitters
- Isolations from poultry meat: 20 - 50% up to 100%
- Other meats: 3 - 5%
- Industrialized countries: Manifestations are severe
- In Asian countries: Symptoms are milder.
• Emerging pathogen of importance: Dairrhoea
• Implicated in extra intestinal infections

- **Pathogen found in aquatic environment**
  - Saline & brackish water
  - Drinking water
  - Treated & un-treated sewage
  - Abattoir waste water
  - Colonize slow sand filters

- **Fish – Major source**

- **Poultry, Mutton, beef, milk, etc. are also found to be contaminated**
## Prevalence in meats

<table>
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<tbody>
<tr>
<td>Mutton</td>
<td>24-37%</td>
<td>Hisar</td>
<td>Khurana and Kumar (1997)</td>
</tr>
<tr>
<td>Poultry</td>
<td>32-38%</td>
<td>Hisar</td>
<td>Khurana and Kumar (1997)</td>
</tr>
<tr>
<td>Poultry meat</td>
<td>16%</td>
<td>Bareilly</td>
<td>Kumar (1998)</td>
</tr>
<tr>
<td>Poultry meat</td>
<td>16%</td>
<td>Bareilly</td>
<td>Ghatak (2005)</td>
</tr>
<tr>
<td>Eggs</td>
<td>12-22%</td>
<td>Bareilly</td>
<td>Agarwal (1997)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kumar (1998)</td>
</tr>
<tr>
<td>Goat meat</td>
<td>12%</td>
<td>Bareilly</td>
<td>Kumar (1998)</td>
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<tr>
<td>Various RTE meat products</td>
<td>14%</td>
<td>Bombay</td>
<td>Waskar (2005)</td>
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## Prevalence in Human

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<tr>
<td>Diarrhoea</td>
<td>6.5%</td>
<td>Chennai</td>
<td>Komathi &lt;i&gt;et al.&lt;/i&gt;, (1998)</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>8%</td>
<td>Kolkata</td>
<td>Chaterjee and Neogy (1972)</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>0.2%</td>
<td>Vellore</td>
<td>Jesudasan and koshi (1990)</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>6.5%</td>
<td>Bareilly</td>
<td>Ghatak (2005)</td>
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**Clostridium perfringens**

- Meat and poultry: Common pathogen
- Thermostable spores
- Post production temperature abuse
- Large scale production

- Prevalence in meats
  - Buffalo: 40 - 85%
  - Goat: 35 - 75%
  - Poultry: 30 - 75%
- RTE meat and poultry products: 20 – 85%

- Inadequately heated meat dishes
- Human outbreaks
**Staphylococcus aureus**

- Intoxicaton: Thermostable enterotoxin
- Post-production contamination & favourable storage temperature
- Meat and poultry: Less frequently associated
- Milk products: More commonly implicated
- Animals: Mastitis
- Human: Foodborne emetic episodes, pyogenic skin infection, post-operative wound
- Prevalence in meat and poultry products: 10 – 100%
Bacillus cereus

- Diarrhoegenic and Emetic syndrome
- Emetic: Rice dishes
- Diarrhoea: Animal products
- Mild nature of symptoms: Under reported
- Implicated in some foodborne episodes
- Prevalence in meat and poultry products: Variable - 10-70%
• Major cause infant and children diarrhoea
• 100,000 to 150,000 deaths in children
  (Broor et al., 2003)
• Prevalence in diarrhoeal cases: 5-71%
  – In acute diarrhoea: 20-30%

Incidence in animal diarrhoea: 10 -50%
  – Cattle, goats, sheep, pigs

• Animal → Human: Evidence of Zoonoses
  • Bovine- human reassortants
  • Porcine –human reassortants
  • Atypical strains
Norwalk Virus

• Important emerging viral pathogen
  ♣ 3 genogroups (GI, GII, and GIII)

• Human diarrhoea in India: Only few reports 8 – 20%

• One outbreak: Food incriminated: Salad sandwiches
  • Genogroup II

No animal studies
Hepatitis A and E Viruses

- Widely prevalent in India
- Several reports from various parts of India
- Regular outbreaks and sporadic cases
- Epidemics: Every year

- Water: Incriminated in outbreaks
- Association of meat and poultry products: Not reported
Parasites

- Relatively less emphasis given
- **Cysticerosis:**
  - Neurocysticercosis: Partial Seizures: 40% 
  - Taenia: Adult tape worm infection
- **Toxoplasmosis**
- **Amoebiasis**
- **Cryptosoridiosis: Emerging**
- Animals help in perpetuation of Zoonotic Parasites
  
Frequently reported are
- **Fasciolosis**
- **Hydatidosis**
- **Several nematodes**
Other safety issues
Trans-boundary Animal Diseases

- Global trade: Significant food safety issue
- Particularly zoonotic pathogens
  - Contact with animals/foods
    - Avian Influenza
    - BSE
    - RVF
Avian Influenza

- Tremendous loss to poultry Industry
  - Maharashtra and Gujarat 2006
    - 3.45 lakh birds culled
    - 6 lakh eggs & 53 MT feed destroyed
  - West Bengal and Tripura: 2008
    - > 40 lakh birds culled
    - 15 lakh eggs & 80,000 Kg feed destroyed
    (10/32008, DAHD, Govt. India Media notification)
- Controlled: Initiatives and rapid response teams of DAHD, Govt. of India
WHO Food safety information
Avian Influenza

- Conventional cooking (> 70°C) safe: Inactivate virus
- In poultry meat: not killed by refrigeration or freezing
- Home slaughtering and preparation is hazardous
- Eggs contain virus both on outside and inside of shell
- No evidence of infection: If consumed properly cooked poultry and eggs
- Greatest risk in handling and slaughter of live infected birds
Antibiotic Resistance

Increased antibiotic resistance of foodborne pathogens

Antibiotics in feed

Irrational /sub-therapeutic use of antibiotics in treatment

Emergence of resistant foodborne pathogens
Antibiotic Resistance

- Health related issues associated with resistant bacteria
  - Treatment failures
  - Reduced therapeutic options
  - Increased severity of symptoms
Resistance profile of *Salmonella* Virchow

![Bar chart showing resistance profile](chart.jpg)

Cs: Cefoperazone; Ci: Ceftriaxone; Do: Doxycycline; Ce: Cephotaxime; T: Tetracycline; Cf: Ciprofloxacin; N: Neomycin; K: Knamamycin; Fr: Furazolidone

N = 109
Antibiotic Resistance

MAR index of Aeromonas isolates from various sources

Fish  Chicken  Human
Antibiotic Resistance

Antibiotic resistance pattern of S. aureus isolates

Resistant to No. of antibiotics

RTE food products  Animal cases  human cases
Other microbial safety issues......

- Surveillance of Foodborne Disease
  - What we know...
  - (reported cases)
  - What we need to know!

- WHO Initiative for global FBD Burden
  - Needs to be established

- Surveillance network for zoonotic diseases
  - In pipeline
  - Non-existent
Other microbial safety issues......

- Traceability of animals
- Microbial source tracking
  - Molecular epidemiology of pathogen
  - Advanced genomic and proteomic tools
- Improvement and establishment of modern abattoirs
- Systematic rearing of meat animal

National Meat and Poultry Development Board
Risk Assessment Essential

Hazard Identification

Hazard Characterization

INDIAN MEAT & POULTRY PRODUCTS

Food Intake Assessment

Risk Characterization
Establishment of Microbial Standards

- Standards available for few meat and poultry products

<table>
<thead>
<tr>
<th>Frozen meats</th>
<th>Characteristic</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total plate count</td>
<td>10000/g</td>
</tr>
<tr>
<td></td>
<td><em>E. coli</em></td>
<td>100/g</td>
</tr>
<tr>
<td></td>
<td><em>Staph aureus</em></td>
<td>100/g</td>
</tr>
<tr>
<td></td>
<td><em>Cl. perfringens and Cl. botulinum</em></td>
<td>30/g</td>
</tr>
<tr>
<td></td>
<td><em>Salmonella</em></td>
<td>Absent in 25 g</td>
</tr>
<tr>
<td></td>
<td><em>Listeria monocytogenes</em></td>
<td>Absent in 25 g</td>
</tr>
</tbody>
</table>
Microbial Standards ........

Corned beef, luncheon meat, cooked ham, canned meat

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</table>

Essential to develop standards for Indian meat and poultry products
Challenges ahead

- Specific rearing of meat animals as Backward integration to modern meat plants
- Disease free zones
- Control of trans-boundary diseases

Healthy animals

- Surveillance of foodborne & zoonotic diseases
- Risk assessment & microbial standards
- Animal traceability & microbial tracking
- Improvement of slaughter facility
- Monitoring of antimicrobial resistance

Safe & Quality

Meat & Poultry Products

Healthy Human
Advantages /strengths

- Food Safety and Standards Authority- Established
- Excellent veterinary infrastructure
  - 26,717 polyclinics/ dispensaries/hospitals
  - 28,195 Veterinary aid centers
  - 9 Veterinary universities
  - > 40 Veterinary colleges

- Scientific & Trained manpower
  - In Veterinary Public Health and Food Safety
  - In new technologies such as genomics, proteomics
Advantages /strengths……..

- High Security Animal Disease Laboratory, IVRI, Bhopal
  - One of the best in the world
  - Excellent Infrastructure
  - BSL 4 pathogens
  - Exotic animal diseases

- Animal disease surveillance system through
  - Central Disease Diagnostic Laboratory, IVRI
  - Regional Disease Diagnostic Laboratories (each zone)

- Integrated disease surveillance programme (IDSP) by Ministry of health and family welfare
  - Needs strengthening by collaborative efforts i.e. participation of veterinarians for control of meat borne diseases
Advantages /strengths........

- Absence of some important trade and food safety related diseases in Indian livestock
  - BSE, scrapie, CBPP, RP, RVF, etc
- Availability of modern and integrated export oriented meat processing units which are HAACCP certified
- A well organized poultry sector.
- Indian eating/cooking habit
  - Fresh meat preferred
  - Meat : Pressure cooked/high temperature
“To succeed in a mission, you must have single minded devotion to your goal”

Dr. APJ Abdul Kalam
Thank You