Status of Microbiological Standards as per Food Safety Standards Regulations and its Comparison with Different International Standards

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Overview

- Food safety
- Trends in Meat Production in India
- Microbiological Specification/Criteria
- Need to form Microbiological Criteria
- Status of Microbiological Standards of India
- Microbiological Standards of Different Countries
- Challenges Ahead for Microbiological Standards
- Conclusions

Why Food Safety ?

- Changing food habits
- Increased processing/ handling
- Changing processes / products
- Globalization of food trade

(Madhvapaty and Dasgupta, 2015)

FOOD SAFETY A GLOBAL CONCERN

Food-Borne Disease Outbreaks 2016

- Outbreaks Reported : 1,892
- Cases of illness : 48 Million cases/ Year
- Hospitalization : 1,28,000
- Deaths : 3,000

(CDC, 2018)

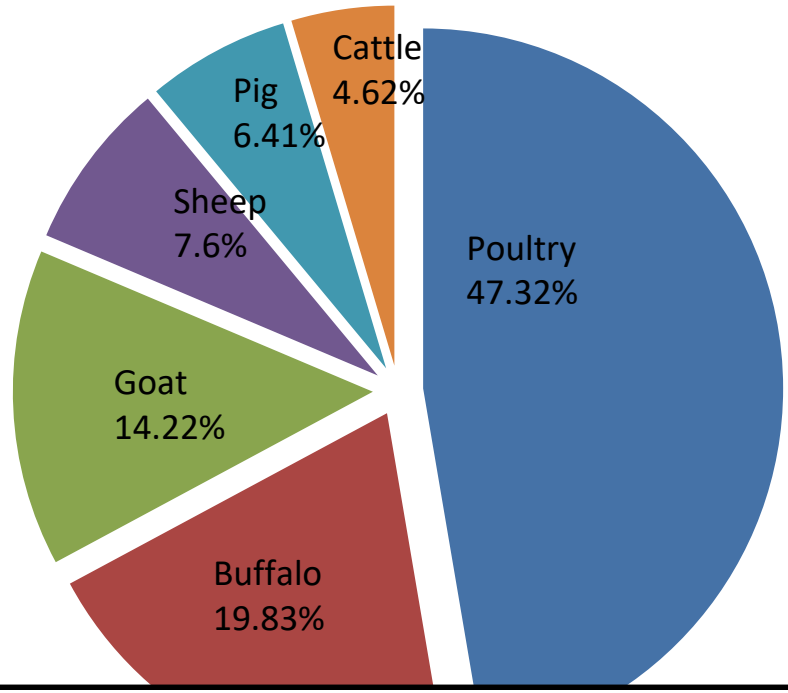
Livestock Wealth *vs.* Meat Production in India

Species	Population (Millions)	Meat Production (MT)
Cattle	190.12	337.91
Buffalo	108.7	1450.98
Sheep	65.07	556.44
Goat	135.17	1041.11
Pig	10.12	468.80
Poultry	729.21	3643.45

19th Livestock Census, DAHD & F, 2017

Species-wise contribution

- ✓ **Poultry Meat** **47.32%**
- ✓ **Bovine Meat** **24.45%**
- ✓ **Small Ruminants** **21.82%**
- ✓ **Pigs** **6.41%**



Basic Animal Husbandry & Fisheries Statistics (2017). Animal Husbandry Statistics Division, DADF, MoA, GoI

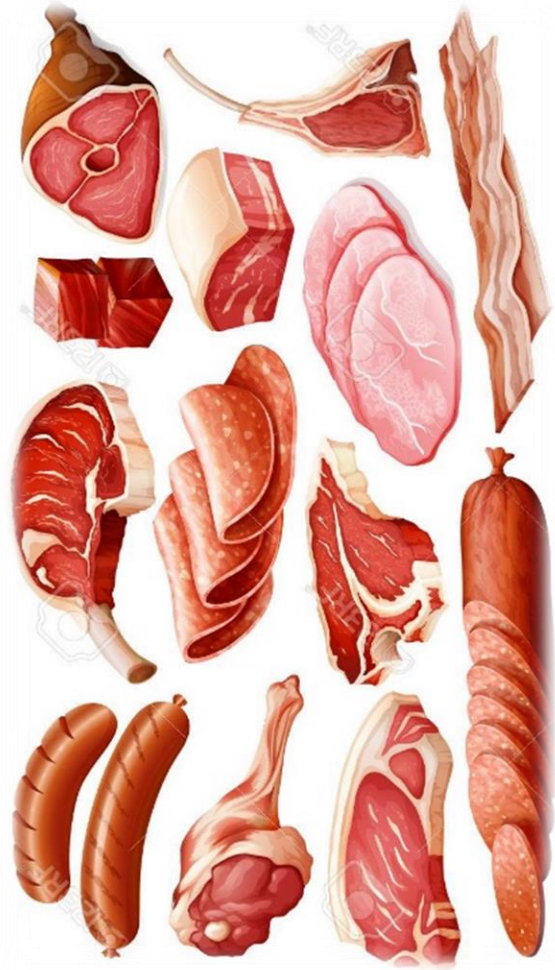
Peculiarities of India

- Share in world meat production= 2.2%
- Species-wise contribution
  - Poultry 47.32%
  - Buffalo 19.83%
  - Goat 14.22%
  - Sheep 7.60%
  - Pig 6.41%
  - Cattle 4.62%

INDIAN MEAT INDUSTRY

- Total Meat Production : 7.4 Million Tonnes
- Value of Meat Produced : Rs. 29,813 Crores
- Value of Meat Products : Rs. 950 Crores

- Registered number 0f slaughter houses : 3,900
- Unregistered slaughter houses : 25,750
- Abattoir cum Meat Processing Units : 80
- Meat Processing Units : 29
- EIC approved Meat /Poultry Products Units : 15

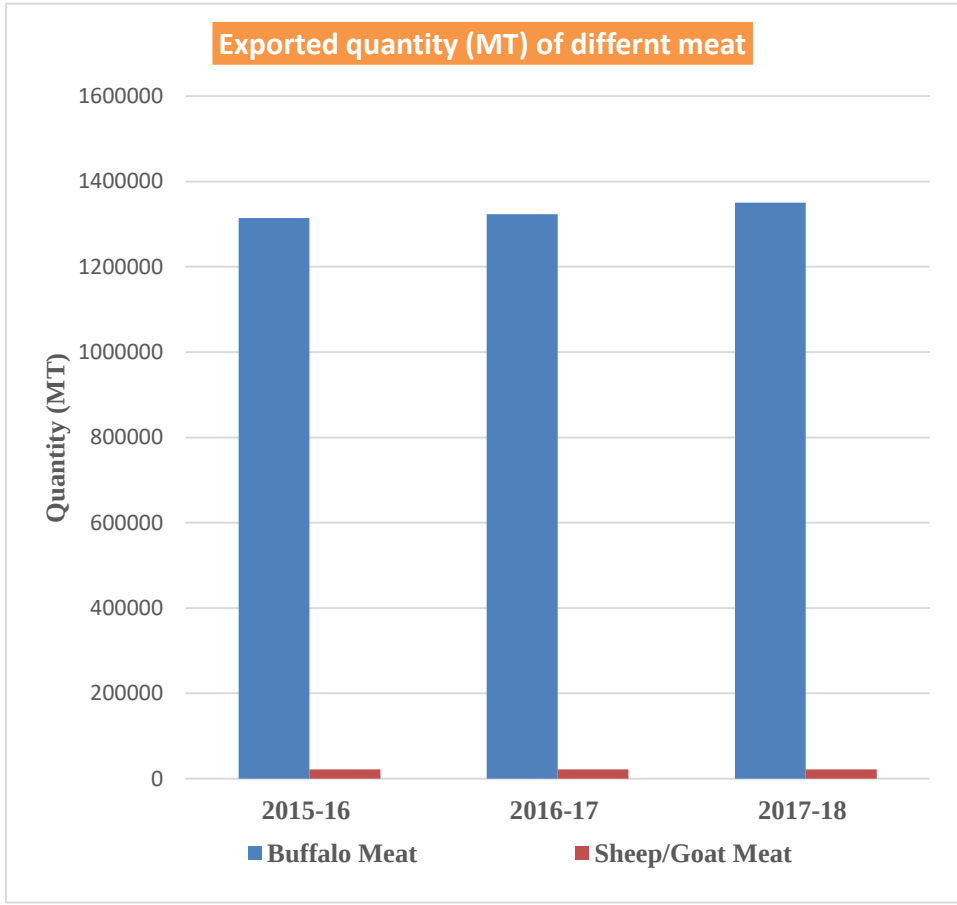


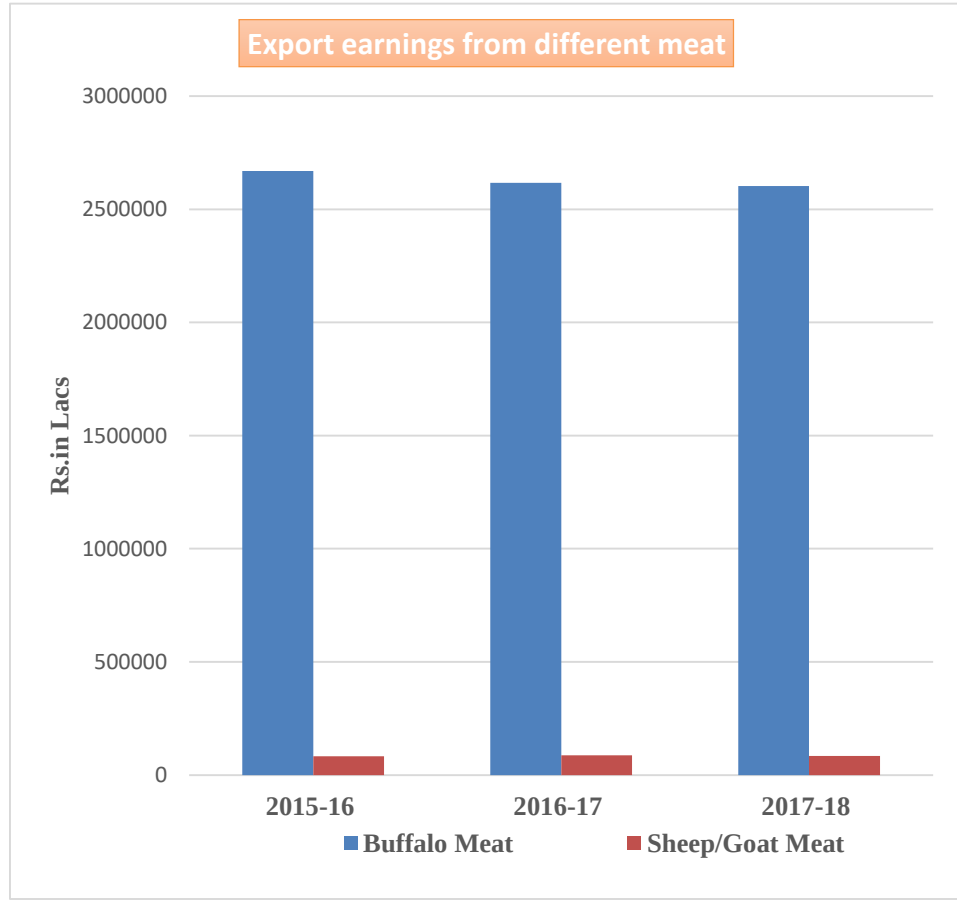
(APEDA and EIC, 2018)

MEAT EXPORT

Buffalo meat : 13,50,563.48 MT ; Value of Rs. 26,033.82 Crores

Sheep/goat meat : 21,906.51 MT ; Value of Rs. 835.74 Crores





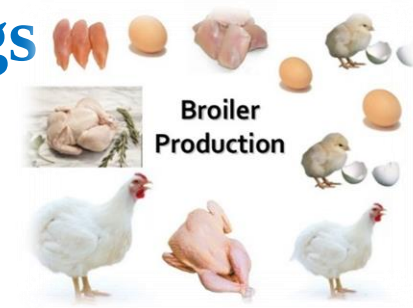
(APEDA, 2017-18)

INDIAN POULTRY INDUSTRY

- **Transformation from backyard to organized industry**
  - **Organized sector : 70%**
  - **Unorganized sector : 30%**

- **Broiler production : 4.9 Million MT**
  (4th in Broiler Production)

- **Egg production : 88.139 Billion eggs**
  (3rd in Egg Production)



- **Products export : Rs. 515.90 Crore**

(Annual Report of DAHD &F, 2017-18)

INCREASED DEMAND

Type of Meat	Demand (Million MT)	Rural (%)	Urban (%)
Sheep and Goat	4.57	16.19	83.81
Beef and Buffalo	1.00	53.00	47.00
Chicken	0.64	45.31	54.69
Eggs	31.47 (Billion)	45.41	54.59

Trends in Meat and Egg Production in India

Year	Meat (Million MT)	Eggs (Million No.)
2012-13	5.9	69731
2013-14	6.2	73438
2014-15	6.7	78484
2015-16	7.0	82929
2016-17	7.4	88139

Dept. of Animal Husbandry GOI, 2017

Quality and Food Safety Issues

- Hazards and Risk Analysis
  - Physical
  - Chemical
  - **Microbial** ……Most predominant! / of concern!!!!!
- Public health protection
- Trade implications
- Export options

Microbiological Food Safety Challenges

- **Microbiological concerns in Meat & Meat products**
  - **Contaminants……QUALITY**
  - **Pathogens……SAFETY**

Bacterial Food-borne Illness

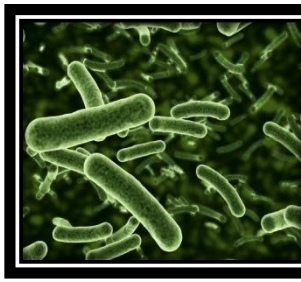
Involvement

- Improper holding temperature : 63%
- Poor personal hygiene : 28%
- Contaminated equipment : 23%
- Inadequate cooking : 21%
- Food from unsafe source : 12%
- Others : 20%

(Multiple factors)

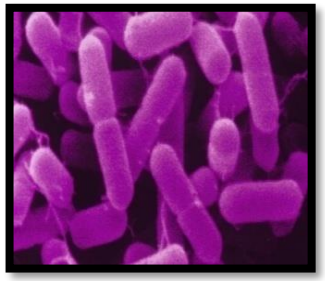
Microbial hazards (Major)
Campylobacter jejuni
Salmonella
E. coli O157:H7
Listeria monocytogenes
Bacillus cereus
S. aureus
Clostridium botulinum
Yersinia enterocolitica
Mycobacterium paratuberculosis
Clostridium botulinum

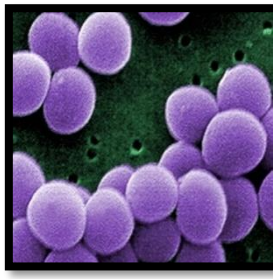
Study…



Prevalence of Pathogenic Bacteria in Chicken Meat

- ✓*Campylobacter* spp. : *95%*
- ✓*Escherichia coli* : *70.22%*
- ✓*Clostridium* spp. : *13.88%*
- ✓*Listeria monocytogenes* : *15%*
- ✓*Staphylococcus aureus* : *11.25%*





(Darshana et al., 2014)

Microbiological Criteria/ Specifications defined

Microbiological Criteria

A Microbiological criterion for food defines the **Acceptability** of a product or a food lot, based on the **Absence or Presence**, or number of microorganisms including parasites or quantity of their toxins/metabolites, per unit(s) of mass, volume, area or lot

Microbiological Specifications

A microbiological specification is a microbiological criteria that is used as a **Purchase** requirement whereby **Conformance** with it becomes a condition of purchase between buyer and vendor of a food or an ingredient

Microbiological Standard/ Limit Defined

Microbiological Standard

Mandatory Microbiological Criteria which are written into **Law** or **Government Regulations** and specified by government to protect **Public health**

Microbiological Limit

Microbiological Limits used in criteria should be based on microbiological data appropriate to the food and should be applicable to a variety of similar products

Based on data gathered at various production establishments operating under Good Hygienic Practices and applying the HACCP system

Need to Form Microbiological Criteria

- Evidence of Actual or Potential Health Hazards
- Effect of Further Processing on the likely Microbiological status of the Food and intended use of the Product
- Likelihood and consequences of Microbial Contamination and Growth during subsequent handling, storage and use
- Underlying health of the consumers

(Codex Alimentarius Commission, 2019)

Food Safety and Standards Act, 2006

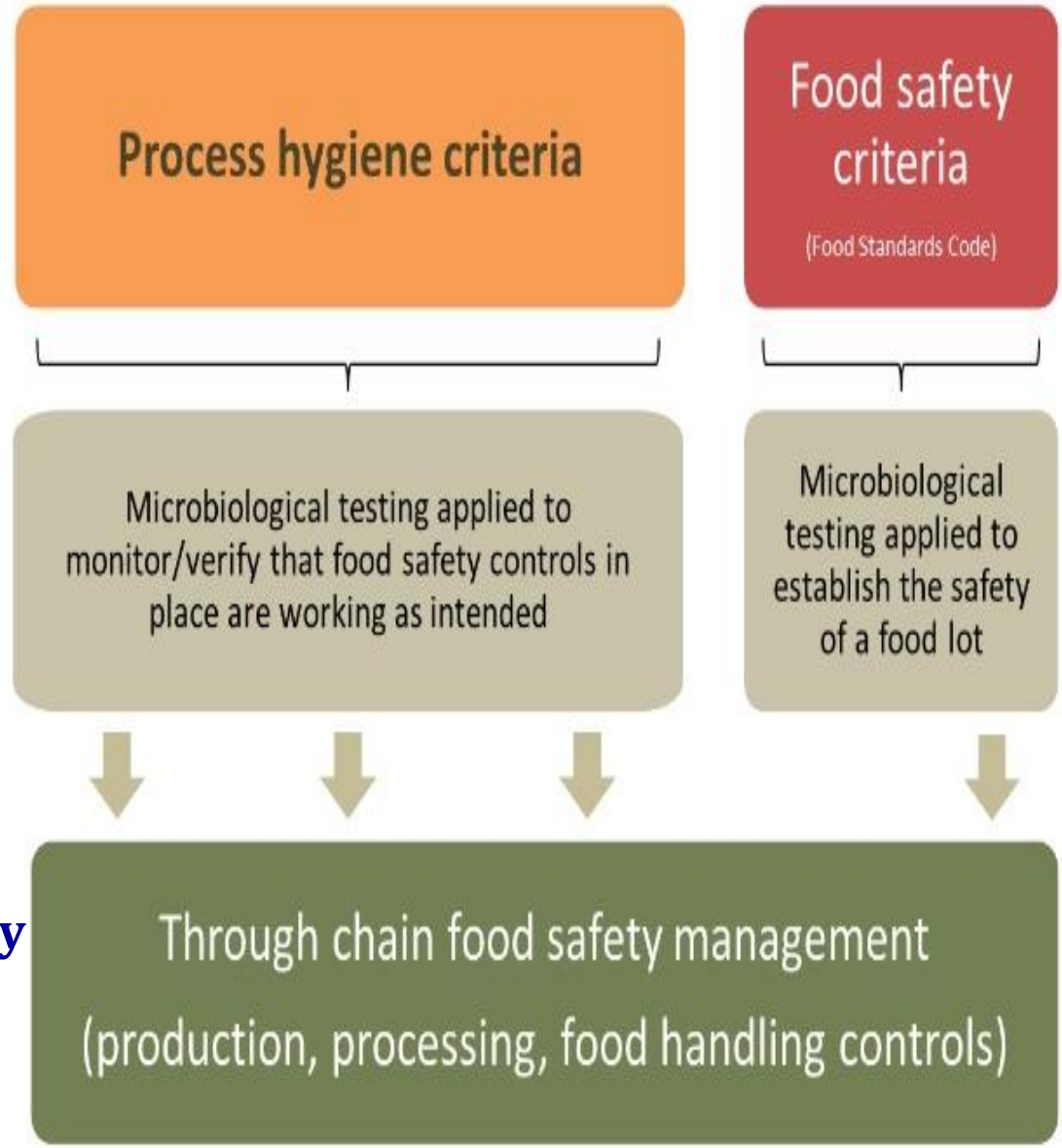
1. To consolidate multiple laws and establish single point reference system
2. To establish Food Safety and Standards Authority of India
3. To regulate the manufacture, storage, distribution, sale and import of food products
4. To ensure availability of safe and wholesome food for human consumption

Regulatory Framework on Microbiological Standards for Meat & Meat Products

- FSSAI microbiological standards for meat products
  (w.e.f. 10th Oct. 2016; time-to-time updating)
- Table: 5 A & 5B, Appendix B of the FSSR
  (Food Products Standards and Food Additives), 2011; Total 9 Meat categories

Microbiological standards

1. **Process Hygiene Criteria – Hygiene Indicator Organisms**
2. **Food Safety Criteria – Food Safety Indicator Organisms**



Process Hygiene Indicators & Food Safety Indicators

Hygiene Indicators
•Aerobic Plate count (APC)
•Yeast and mold count
•*Escherichia coli*
•*Staphylococcus aureus*

Food Safety Indicators
• *Salmonella*
• *Listeria monocytogenes*
•*Sulphite reducing Clostridia*
•*Clostridium botulinum*
•*Campylobacter* Spp.

Microbiological Standards in Food Chain – Stages of Application

- **Process Hygiene Criteria**
  - At the end of the manufacturing process
  - Acceptable functioning of the production process
  - If values above standards then corrective actions are required in order to maintain the hygiene of the process
  - Not to be used as requirements for releasing the products in the market
- **Food Safety Criteria**
  - At the end of the manufacturing process
  - Products in the market (shelf- life)
  - Define the acceptability of a batch/lot
  - Releasing the Product to the market

Process Hygiene Criteria

In case of non-compliances -

check and improve process hygiene by implementation of guidelines in Schedule 4 (Part II Part IV) of FSS (Licensing and Registration of Food Businesses) Regulations;

FSMS
(GMP, GHP. PRPs, oPRP & CCPs)

Food Safety Criteria

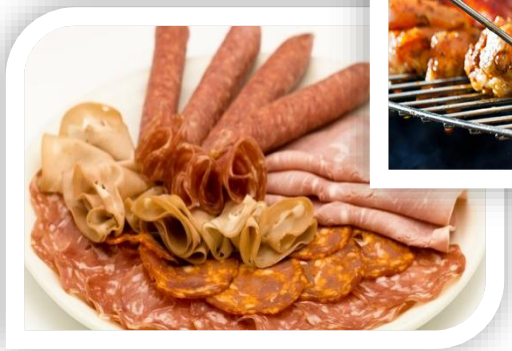
Compulsory compliance is required before releasing the product batch/lot in the market otherwise reject

Meat Categories under FSSAI Microbial standards

1) Fresh meat / Chilled meat
2) Frozen meat
3) Raw marinated/minced/comminuted meat
4) Semi cooked/Smoked meat/meat food products
5) Cured/Pickled meat
6) Fermented meat products
7) Dried/Dehydrated meat products
8) Cooked meat products
9) Canned/Retort pouch meat products







Action in case of Unsatisfactory Result/s

❖ Control, Preventive & Assurance Activities

- **Control Activities**
  - Aiming at prevention or reduction of a food safety hazard
  - Typically related to product and process controls
- **Preventive Activities – Prerequisite programs**
  - Cleaning and sanitation
  - Temperature control of the production environment
  - Personal Hygiene of the workers
  - Pest Control
  - Prevention of Cross Contamination
- **Assurance Activities**
  - Food safety management system - having the objective to provide evidence that products and processes are within the set specifications

Microbiological Standards for Meat and Meat Products- Process Hygiene

S. No.	Product Category[1]	Aerobic Plate Count				Yeast and Mold Count				*Escherichia coli*				*Staphylococcus aureus* (Coagulase +ve)			
		Sampling Plan		Limits (cfu/g)		Sampling Plan		Limits (cfu/g)		Sampling Plan		Limits (cfu/g)		Sampling Plan		Limits (cfu/g)	
		n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
(1)	Fresh meat/ Chilled meat[2]	5	3	$1x10^6$	$5x10^6$	5	2	$1x10^4$	$5x10^4$	5	2	$1x10^2$	$1x10^3$	5	2	$1x10^2$	$1x10^3$
(2)	Frozen meat[2]	5	2	$1x10^5$	$5x10^6$	5	2	$1x10^3$	$1x10^4$	5	2	1x10	$1x10^2$	5	2	10	$1x10^2$
(3)	Raw marinated/minced/comminuted meat[2]	5	2	$5x10^5$	$5x10^6$	5	2	$1x10^2$	$1x10^3$	5	2	$1x10^2$	$1x10^3$	5	2	$1x10^2$	$1x10^3$
(4)	Semi-cooked /Smoked Meat/ meat food Product[2]	5	2	$1x10^4$	$1x10^5$	5	2	10	$1x10^2$	5	2	10	$1x10^2$	5	2	10	$1x10^2$
(5)	Cured/Pickled meat	5	2	$5x10^2$	$5x10^3$	5	2	$1x10^2$	$1x10^3$	5	2	10	$1x10^2$	5	1	$1x10^2$	$1x10^3$
(6)	Fermented meat products	NA	NA	NA	NA	NA	NA	NA	NA	5	2	10	$1x10^2$	5	1	$1x10^2$	$1x10^3$
(7)	Dried/dehydrated meat product	5	2	$1x10^3$	$1x10^4$	5	2	$1x10^2$	$1x10^3$	5	2	10	$1x10^2$	5	1	10	$1x10^2$
(8)	Cooked Meat Products	5	2	$1x10^3$	$1x10^4$	5	1	10	$1x10^2$	5	2	10	$1x10^2$	5	1	10	$1x10^2$
(9)	Canned/Retort pouch Meat Products	NA	NA	NA	NA	NA	NA	NA	NA	5	0	Absent	NA	5	0	Absent	NA
	Test Methods[3]	**IS: 5402/ISO 4833**				**IS: 5403/ISO 21527**				**IS: 5887 Part1 or ISO 16649-2**				**IS 5887 : Part 2 or IS 5887 Part 8 (Sec 1)/ ISO : 6888-1 or IS 5887 Part 8 (Sec 2)/ISO 6888-2**			

FSSAI Gazette Notification 10th October, 2016

Microbiological Standards for Meat and Meat Products

Sr. No.	Product Category[1]	*Salmonella*			*Listeria monocytogenes*			Sulphite Reducing Clostridia				*Clostridium Botulinum*				*Campylobacter* Spp*			
		Sampling Plan		Limits (cfu/25g)	Sampling Plan		Limits (cfu/25g)	Sampling Plan		Limits (cfu/g)		Sampling Plan		Limits (cfu/g)		Sampling Plan		Limits (cfu/g)	
		n	c	m M	n	C	m M	n	c	m	M	n	c	m	M	n	c	m	M
1.	Fresh meat / Chilled meat[2]	5	0	Absent	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.	Frozen meat[2]	5	0	Absent	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.	Raw marinated/minced/comminuted meats[2]	5	0	Absent	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.	Semi-cooked /Smoked Meat/meat food Product[2]	5	0	Absent	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	0	Absent	
5.	Cured/Pickled meat	5	0	Absent	5	0	Absent	5	2	$5x10^2$	$5x10^3$	NA	NA	NA	NA	NA	NA	NA	NA
6.	Fermented meat products	5	0	Absent	5	0	Absent	5	2	$5x10^2$	$5x10^3$	NA	NA	NA	NA	NA	NA	NA	NA
7.	Dried/dehydrated meat product	5	0	Absent	5	0	Absent	5	2	$5x10^2$	$5x10^3$	NA	NA	NA	NA	NA	NA	NA	
8.	Cooked Meat Products	5	0	Absent	5	0	Absent	5	1	$1x10^2$	$1x10^3$	NA	NA	NA	NA	5	0	Absent	
9.	Canned/ Retort pouch Meat Products	5	0	Absent	5	0	Absent	5	0	Absent		5	0	Absent		5	0	Absent	
	Test Methods[3]	**IS: 5887 Part 3/ ISO 6579**			**IS: 14988, Part 1 &2/ISO 11290-1 & 2**			**ISO 15213**				**IS:5887, Part 4 or ISO 17919**				**ISO 10272-1&2**			

FSSAI Gazette Notification 10th October, 2016

Sampling Plan & Interpretation of Results

❖ Sampling Plan:

Terms n, c, m and M used in this standard have the following meaning:

- n = Number of units comprising a sample .
- c = Maximum allowable number of units having microbiological counts above m for 2- class sampling plan and between m and M for 3- class sampling plan.
- m = Microbiological limit that separates unsatisfactory from satisfactory in a 2- class sampling plan or acceptable from satisfactory in a 3-class sampling plan.
- M = Microbiological limit that separates unsatisfactory from satisfactory in a 3-class sampling plan.

❖ Interpretation of Results:

2-Class Sampling Plan (where n, c and m are specified)

1. Satisfactory, if all the values observed are ≤ m
2. Unsatisfactory, if one or more of the values observed are >m or more than c values are > m

3-Class Sampling Plan (where n, c, m and M are specified)

1. Satisfactory, if all the values observed are ≤ m
2. Acceptable, if a maximum of c values are between m and M and the rest of the values are observed as ≤ m
3. Unsatisfactory, if one or more of the values observed are >M or more than c values are > m

COMPARISON OF FSSAI STANDARDS WITH OTHER COUNTRIES

PROCESS HYGIENE CRITERIA

Microbiological Standards for Raw/ Fresh Meat/ Chilled Meat/Frozen Meat

Org.	FSSAI				Australia				Qatar				Thailand				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
APC	5	3	$1x10^6$	$5X10^6$	5	2	10^4	10^5	5	2	10^5	10^6	-	-	$5x10^5$	-	5	3	$5\ X10^5$	10^7
E.coli	5	2	10^2	10^3	5	2	10^1	10^2	-	-	-	-	-	-	$5x10^3$	-	-	-	-	-
Y & M	5	2	10^2	10^3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. aureus	5	2	10^2	10^3	5	2	10^2	10^3	-	-	-	-	-	-	$1x10^2$	-	5	2	10^2	10^3

Microbiological Standards for Raw Marinated/ Minced /Comminuted Meat

Org	FSSAI				New Zealand				Australia				Qatar				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
APC	5	2	$5x10^5$	$5x10^6$	5	3	$5x10^5$	$5x10^6$	5	2	10^4	10^5	5	3	10^6	10^7	5	2	10^4	10^5
E.coli	5	2	10^2	10^3	-	-	-	-	5	2	10	10^2	5	0	0	O157	5	2	10	10^2
Y & M	5	2	10^2	10^3	-	-	-	-	-	-	-	-	-	-	-	-				
S. aureus	5	2	10^2	10^3	5	2	10^2	10^3	5	2	10^2	10^3	5	2	$5x10^2$	10^3	5	1	10^2	10^3

Microbiological Standards for Semi Cooked/ Smoked Meat/ Meat Food Products

Org	FSSAI				New Zealand				Australia				Qatar				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
APC	5	2	10^4	10^5	5	2	10^4	10^5	5	2	10^4	10^5	5	3	10^4	10^5	-	-	-	-
E.coli	5	2	10	10^2	-	-	-	-	5	2	10	10^2	-	-	-	-	-	-	-	-
Y & M	5	2	10	10^2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. aureus	5	2	10	10^2	5	2	10^2	10^3	5	2	10^2	10^3	10	2	10^3	10^4	10	1	10^3	10^4

Microbiological Standards for Cured/Pickled meat

Org	FSSAI				New Zealand				Australia				Qatar			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
APC	5	2	$5x10^2$	$5x10^3$	5	3	$5x10^5$	$5x10^6$	5	2	10^4	10^5	5	3	10^4	10^5
E.coli	5	2	10	10^2	-	-	-	-	5	2	10	10^2	-	-	-	-
Y & M	5	2	10^2	10^3	-	-	-	-	-	-	-	-	-	-	-	-
S. aureus	5	1	10^2	10^3	5	3	10^2	10^3	5	2	10^2	10^3	10	2	10^3	10^4

Microbiological Standards for Fermented Meat Products

Org	FSSAI				New Zealand				Australia				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
APC	NA	NA	NA	NA	-	-	-	-	5	2	10^4	10^5	-		-	-
E.coli	5	2	10	10^2	-	-	-	-	5	2	10	10^2	5	0	1.8	MPN
Y & M	NA	NA	NA	NA	-	-	-	-	-	-	-	-	-	-	-	-
S. aureus	5	1	10^2	10^3	5	2	10^2	10^3	5	2	10^2	10^3	5	1	10^3	-

Microbiological Standards for Dried/ Dehydrated Meat Products

Org	FSSAI				Australia				Qatar				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
APC	5	2	10^3	10^4	5	2	10^4	10^5	-	-	-	-	-		-	-
E.coli	5	2	10	10^2	5	2	10	10^2	-	-	-	-	5	0	1.8	MPN
Y & M	5	2	10^2	10^3	-	-	-	-	-	-	-	-	-	-	-	-
S. aureus	5	1	10	10^2	5	2	10^2	10^3	5	3	10^2	10^3	5	1	10^2	10^4

Microbiological Standards for Cooked Meat Products

	FSSAI				ICMSF				Newzeland				Australia				Qatar				Thai				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
APC	5	2	10^3	10^4	5	2	10^4	10^5	-	-	-	-	5	2	10^4	10^5	5	2	10^4	10^5	-	-	-	-	-		-	-
E.coli	5	2	10	10^2	5	2	10	10^2	-	-	-	-	5	2	10	10^2	-	-	-	-	-	-	-	-	-	-	-	-
Y & M	5	1	10	10^2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. aureus	5	1	10	10^2	5	1	10^2	10^3	-	-	-	-	5	2	10^2	10^3	5	1	10^2	10^3	-	-	-	-	5	2	10^2	10^3
																									5	1	10^3	10^4

Blue: Packaged cooked cured meat Ham/Bacon), Green: cooked poultry meat frozen reheated before eating

Microbiological Standards for Canned/Retort Pouch Meat Products

	FSSAI				Australia			
	n	c	m	M	n	c	m	M
APC	NA	NA	NA	NA	5	2	10^4	10^5
E. coli	5	0	AB	NA	5	2	10	10^2
Y & M	NA	NA	NA	NA	-	-	-	-
S. aureus	5	0	AB	NA	5	2	10^2	10^3

Comparison of FSSAI standards with other country standards

FOOD SAFETY CRITERIA

Microbiological Standards for Raw/ Fresh Meat/ Chilled Meat/Frozen Meat

Org	FSSAI				ICMSF				Newzeland				Australia				Qatar				Thai				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
Sal	5	0	Ab	Ab	-	-	-	-	5	1	0	0	-	-	-	-	5	0	Ab	Ab	5	0	Ab		10	0	0	-
	5	0	Ab	Ab													5	0	Ab	Ab								
LM	NA	NA	NA	NA	-	-	-	-	-	-	-	-					-	-	-	-	-	-	-	-	-	-	-	-
SRC	NA	NA	NA	NA	-	-	-	-	5	3	10^2	10^3	5	2	10^2	10^3	5	2	2	10^3	-	-	-	-	5	2	10^2	10^3
C.Botulm	NA	NA	NA	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Campl	NA	NA	NA	NA					5	1	0	-	5	0	0		5	0	0	0								

Microbiological Standards for Raw Marinated\ Minced Comminuted Meat

Org	FSSAI				Australia				Qatar				Thai			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
Sal	5	0	Ab	Ab	-	-	-	-	5	0	Ab	Ab	5	0	Ab	
	5	0	Ab	Ab					5	0	Ab	Ab				
LM	NA	NA	NA	NA					-	-	-	-	-	-	-	-
SRC	NA	NA	NA	NA	5	2	10^2	10^3	5	2	10^2	10^3	-	-	-	-
C.Botulm	NA	NA	NA	NA	-	-	-	-	-	-	-	-	-	-	-	-
Campl	NA	NA	NA	NA	5	0	0		-	-	-	-				

Microbiological Standards for Semi Cooked/ Smoked Meat/ Meat Food Products

Org	FSSAI				Newzeland				Australia				Qatar				Thai				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
Sal	5	0	AB	AB	5	0	0	-	-	-	-	-	10	0	AB	AB	5	0	AB	-	10	0	0	-
LM	NA	NA	NA	NA	5	0	0	-					5	0	0	-	-	-	-	-	-	-	-	-
SRC	NA	NA	NA	NA	5	2	10^2	10^3	5	2	10^2	10^3	5	2	10^2	10^3	-	-	-	-	-	-	-	-
C.Botulm	NA	NA	NA	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Campl	5	0	Ab	Ab	5	0	0		5	0	0		5	0	0	-					-	-	-	-

Microbiological Standards for Cured/Pickled Meat

Org	FSSAI				ICMSF				Newzeland				Australia				Thai				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
Sal	5	0	Ab	Ab	-	-	-	-	5	1	0	-	-	-	-	-	5	0	Ab		5	0	0	-
	5	0	Ab	Ab																	-	-	-	-
LM	5	0	Ab	Ab	-	-	-	-	-	-	-	-					-	-	-	-	5	0	0	-
SRC	5	2	$5x\ 10^2$	$5x\ 10^3$	-	-	-	-	5	3	10^2	10^3	5	2	10^2	10^3	-	-	-	-	-	-	-	-
C.Botulinum	NA	NA	NA	NA	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Campl	NA	NA	NA	NA					-				5	0	0						-	-	-	-

Microbiological Standards for Fermented Meat Products

Org	FSSAI				Newzeland				Australia				Thai				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
Sal	5	0	Ab	Ab	5	0	0	-	-	-	-	-	5	0	Ab		5	0	0	10^4
	5	0	Ab	Ab													-	-	-	-
LM	5	0	Ab	Ab	5	0	0	-					-	-	-	-	-	-	-	-
SRC	5	2	$5x\ 10^2$	$5x\ 10^3$	5	2	10^2	10^3	5	2	10^2	10^3	-	-	-	-	-	-	-	-
C.Botulm	NA	NA	NA	NA		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Campl	NA	NA	NA	NA	5	0	0		5	0	0						-	-	-	-

Microbiological Standards for Dried/ Dehydrated Meat Products

Org	FSSAI				Australia				Qatar				Thai				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
Sal	5	0	Ab	Ab	-	-	-	-	10	0	0	-	5	0	Ab		19	0	0	
	5	0	Ab	Ab													-	-	-	-
LM	5	0	Ab	Ab					5	0	0	-	-	-	-	-	-	-	-	-
SRC	5	2	$5x\ 10^2$	$5x\ 10^3$	5	2	10^2	10^3	5	2	10^2	10^3	-	-	-	-	5	1	10^2	10^4
C.Botulm	NA	NA	NA	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Campl	NA	NA	NA	NA	5	0	0										-	-	-	-

Microbiological Standards for Cooked Meat Products

Org	FSSAI				ICMSF				Australia				Thai				Philippines			
	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M	n	c	m	M
Sal	5	0	Ab	Ab	10	0	0	-	-	-	-	-	5	0	Ab		5	0	0	
	5	0	Ab	Ab													-	-	-	-
LM	5	0	Ab	Ab	5	0	0	-					-	-	-	-	-	-	-	-
SRC	5	1	10^2	10^3	5	1	10^2	10^3	5	2	10^2	10^3	-	-	-	-	-	-	-	-
C.Botulm	NA	NA	NA	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Campl	5	0	Ab	Ab					5	0	0						-	-	-	-

Microbiological Standards for Canned/Retort pouch Meat products

Org	FSSAI				Australia				Thai			
	n	c	m	M	n	c	m	M	n	c	m	M
Sal	5	0	Ab	Ab	-	-	-	-	5	0	Ab	
LM	5	0	Ab	Ab					-	-	-	-
SRC	5	0	Ab	Ab	5	2	10^2	10^3	-	-	-	-
C.Botulm	5	0	Ab	Ab	-	-	-	-	-	-	-	-
Campl	5	0	Ab	Ab	5	0	0					

ICMSF (1974) has suggested 2 and 3 class Sampling Plans

❖ **ICMSF (1974) has suggested 2 and 3 class sampling plans**

1) Two class plan/two attribute scheme:

- Two attributes, i.e. presence or absence of an organism in a given sampling unit
- Applied for more hazardous organisms
- e.g. *Clostridium botulinum*

2) Three class plan:

- Three attributes and can divide a lot into three categories:

✓ acceptable (n,m);

✓ unacceptable (>M) and

✓ marginally acceptable(C).

Microbiological Standards for Meat and Meat Products of ICMSF

Cooked Meat				
Aerobic colony count/g	n = 5	c = 2	m = 10^4	M = 10^5
E.coli/g	n = 5	c = 2	m = 10	M = 10^2
Staphylococcus aureus/g	n = 5	c = 1	m = 10^2	M = 10^3
Salmonella/25g	n = 10	c = 0	m = 0	-
Listeria monocytogens/g	n = 5	c = 0	m = 0	-
Cooked Uncured Meat				
Clostridium perfringens/g	n = 5	c = 1	m = 10^2	M = 10^3

(ICMSF,2000)

Microbiological Standards for Meat and Meat Products -New Zealand

Chopped, Minced or Manufactured Meat – Uncooked				
Aerobic plate count at 35°C (/g)	n = 5	c = 3	m = 5×10^5	M = 5×10^6
Campylobacter (/10 g)	n = 5	c = 1	m = 0	
Clostridium perfringens (/g)	n = 5	c = 3	m = 10^2	M = 10^3
Coagulase producing *Staphylococcus* (/g)	n = 5	c = 2	m = 10^2	M = 10^3
Faecal coliform (/g)	n = 5	c = 3	m = 10^2	M = 10^3
Salmonella (/25 g)	n = 5	c = 1	m = 0	

Corned, Cured, Pickled or Salted - Uncooked				
Aerobic plate count at 35°C (/g)	n = 5	c = 3	m = 5×10^5	M = 5×10^6
Clostridium perfringens (/g)	n = 5	c = 3	m = 10^2	M = 10^3
Coagulase producing *Staphylococcus* (/g)	n = 5	c = 3	m = 10^2	M = 10^3
Faecal coliform (/g)	n = 5	c = 3	m = 10^2	M = 10^3
Salmonella (/25 g)	n = 5	c = 1	m = 0	

Microbiological Standards for Meat and Meat Products -New Zealand

Manufactured, Cured or Fermented Meat - Ready-to-Eat				
Bacillus cereus (/g)	n = 5	c = 2	m = 10^3	M = 10^4
Campylobacter (/10 g)	n = 5	c = 0	m = 0	
Clostridium perfringens (/g)	n = 5	c = 2	m = 10^2	M = 10^3
Coagulase producing *Staphylococcus* (/g)	n = 5	c = 2	m = 10^2	M = 10^3
Faecal coliform (/g)	n = 5	c = 2	m = 20	M =2 x 10^2
Listeria monocytogenes (/25 g)	n = 5	c = 0	m = 0	
Salmonella (/25 g)	n = 5	c = 0	m = 0	

Meat Paste or Spread - including Pate				
Aerobic plate count at 35°C (/g)	n = 5	c = 2	m = 10^4	M = 10^5
Bacillus cereus (/g)	n = 5	c = 2	m = 10^2	M = 10^3
Campylobacter (/10 g)	n = 5	c = 0	m = 0	
Clostridium perfringens (/g)	n = 5	c = 2	m = 10^2	M = 10^3
Coagulase producing *Staphylococcus* (/g)	n = 5	c = 2	m = 10^2	M = 10^3
Faecal coliform (/g)	n = 5	c = 2	m = 10	M = 10^2
Listeria monocytogenes (/25 g)	n = 5	c = 0	m = 0	
Salmonella (/25 g)	n = 5	c = 0	m = 0	

Microbiological Standards for Meat and Meat Products -New Zealand

Hot Smoked Meat				
Aerobic plate count at 35°C (/g)	n = 5	c = 2	m = 10^4	M = 10^5
Bacillus cereus (/g)	n = 5	c = 2	m = 10^2	M = 10^3
Campylobacter (/10 g)	n = 5	c = 0	m = 0	
Clostridium perfringens (/g)	n = 5	c = 2	m = 10^2	M = 10^3
Coagulase producing *Staphylococcus* (/g)	n = 5	c = 2	m = 10^2	M = 10^3
Faecal coliform (/g)	n = 5	c = 2	m = 10	M = 10^2
Listeria monocytogenes (/25 g)	n = 5	c = 0	m = 0	
Salmonella (/25 g)	n = 5	c = 0	m = 0	

Microbiological Standards for Meat and Meat Products -New Zealand

Vaccuum Packed-Semi Preserved but Perishable Products				
Aerobic plate count at 35°C (/g)	n = 5	c = 2	m = 10^6	M = 10^7
Bacillus cereus (/g)	n = 5	c = 2	m = 10^2	M = 10^3
Campylobacter (/10 g)	n = 5	c = 0	m = 0	
Clostridium perfringens (/g)	n = 5	c = 2	m = 10	M = 10^2
Coagulase producing *Staphylococcus* (/g)	n = 5	c = 2	m = 10^2	M = 10^3
Listeria monocytogenes (/25 g)	n = 5	c = 0	m = 0	
Salmonella (/25 g)	n = 5	c = 0	m = 0	

(Microbiological Reference Criteria for Food New Zealand, 1995)

Microbiological Standards for Meat and Meat Products in Australia

Meat and Meat Products				
Campylobacter /25g	n = 5	c = 0	m = 0	
Clostridium perfringens /g	n = 5	c = 2	m = 10^2	M = 10^3
Coagulase producing *Staphylococcus* /g	n = 5	c = 2	m = 10^2	M = 10^3
Escherichia coli /g	n = 5	c = 2	m = 10	M = 10^2
SPC/g	n = 5	c = 2	m = 10^4	M = 10^5

(Microbiological limits for Food Australia, 2001)

Microbiological Standards for Meat and Meat Products in Qatar

Raw meat (Chilled/frozen); Whole or Half Carcasses; pieces with or without bones				
Aerobic plate count/g	n = 5	c = 2	m = 10^5	M = 10^6
Salmonella/g	n = 5	c = 0	m = 0	
Escherichia coli O157/g	n = 5	c = 0	m = 0	M = 10^3
Fresh Poultry (Chilled/ Frozen)				
Aerobic plate count/g	n = 5	c = 3	m = 5x10^5	M =5x10^5
*Salmonella**/g	n = 5	c = 1	m = 0	M =0
Campylobacter jejuni/g	n = 5	c = 0	m = 0	M =0
Raw Minced (Meat and Poultry); Chilled/Frozen				
Aerobic plate count/g	n = 5	c = 2	m = 5x10^5	M = 5x10^5
Enterobacteriaceae/g	n = 5	c = 2	m = 10^2	M =10^3
Salmonella	n = 5	c = 0	m = 0	-
Escherichia coli O157/g	n = 5	c = 0	m = 0	-
Staphylococcus aureus/g	n = 5	c = 2	m = 2	M =10^3
Clostridium perfringens/g	n = 5	c = 2	m = 2	M =10^3

Microbiological Standards for Meat and Meat Products in Qatar

Raw Minced/Pieces of Meat (Chilled/ Frozen) with Soy or Marinated (e.g. Kebab; Meat Balls, Fresh Sausage, Meat Burgers)				
Aerobic plate count/g	n = 5	c = 3	m = 10^6	M = 10^7
Salmonella/g	n = 5	c = 0	m = 0	
Escherichia coli O157/g	n = 5	c = 0	m = 0	
Staphylococcus aureus/g	n = 5	c = 2	m = $5x10^2$	M = 10^3
Clostridium perfringens/g	n = 5	c = 2	m = 10^2	M = 10^3
Raw edible offal (Chilled/Frozen) e.g. liver, kidney, gizzard				
Aerobic plate count/g	n = 5	c = 2	m = 10^5	M =10^6
Salmonella	n = 5	c = 0	m = 0	M =0
Cured and/ Smoked Luncheon Meat				
Aerobic plate count/g	n = 5	c = 3	m = $5x10^5$	M = $5x10^6$
Salmonella/g	n = 10	c = 0	m = 0	M =10^3
Escherichia coli O157/g	n = 5	c = 0	m = 0	-
Listeria monocytogenes/g	n = 5	c = 0	m = 0	-
Staphylococcus aureus/g	n = 5	c = 2	m = $5x10^5$	M =10^3
Bacillus cereus/g	n = 5	c = 2	m = 10^2	M =10^3
Clostridium perfringens/g	n = 5	c = 2	m = 10^2	M =10^3

Microbiological Standards for Meat and Meat Products in Qatar

Cured and/Smoked Poultry Meat; Mortadella, Frankfurters, Turkey, Smoked Turkey Breast				
Aerobic plate count/g	n = 5	c = 3	m = 10^4	M = 10^5
Salmonella/g	n = 10	c = 0	m = 0	-
Campylobacter jejuni	n = 5	c = 0	m = 0	-
Listeria monocytogenes	n = 5	c = 0	m = 0	-
Staphylococcus aureus	n = 10	c = 2	m = 10^3	M = 10^4
Bacillus cereus	n = 5	c = 2	m = 10^2	M = 10^3
Clostridium perfringens	n = 5	c = 2	m = 10^2	M = 10^3
Cooked Sausages				
Aerobic plate count	n = 5	c = 2	m = 10^4	m = 10^5
Salmonella	n = 5	c = 0	m = 0	-
Staphylococcus aureus	n = 5	c = 1	m = 10^2	M = 10^3
Clostridium perfringens	n = 5	c = 2	m = 10^2	M = 10^3

Microbiological Standards for Meat and Meat Products in Qatar

Cooked Poultry Meat, Frozen - to be Reheated before Eating (e.g. chicken burgers, chicken/ turkey rolls chicken nuggets, others breaded poultry products)				
Aerobic plate count/g	n = 5	c = 3	m = 10^4	M = 10^5
Salmonella/g	n = 5	c = 0	m = 0	-
Campylobacter jejuni/g	n = 5	c = 0	m = 0	-
Escherichia coli O157/g	n = 5	c = 0	m = 0	-
Listeria monocytogenes/g	n = 5	c = 0	m = 0	-
Staphylococcus aureus/g	n = 5	c = 1	m = 10^3	M = 10^4
Bacillus cereus/g	n = 5	c = 2	m = 10^2	M = 10^3
Clostridium perfringens/g	n = 5	c = 2	m = 10^2	M = 10^3
Meat and Poultry Soup				
Aerobic plate count/g	n = 5	c = 1	m = 10^4	M = 10^5
Enterobacteriaceae/g	n = 5	c = 1	m = 10	M = 10^2
Salmonella/g	n = 10	c = 0	m = 0	-
Bacillus cereus/g	n = 5	c = 1	m = 10^3	M = 10^4
Clostridium perfringens/g	n = 5	c = 1	m = 10^2	M = 10^3

Microbiological Standards for Meat and Meat Products in Qatar

Dehydrated Meat or Meat Components; Protein Concentrates from Meat				
Salmonella/g	n = 10	c = 0	m = 0	-
Listeria monocytogenes/g	n = 5	c = 0	m = 0	-
Staphylococcus aureus/g	n = 5	c = 3	m = 10^2	M = 10^3
Clostridium perfringens/g	n = 5	c = 2	m = 10^2	M = 10^3
Preserved but Perishable Meat and Poultry Products				
Aerobic plate count/g	n = 5	c = 2	m = 10^6	M = 10^7
Salmonella/g	n = 5	c = 0	m = 0	-
Campylobacter jejuni/g	n = 5	c = 0	m = 0	-
Staphylococcus aureus/g	n = 5	c = 2	m = 10^2	M = 10^3
Clostridium perfringens/g	n = 5	c = 2	m = 10	M = 10^2

(Microbiological criteria for foodstuffs Qatar, 1998)

Microbiological limits of Chicken in Thailand

- Total count shall not exceed $5x10^5$ colonies per gram of sample
- Coliform count shall not exceed $5x10^3$ colonies per gram of sample
- *Staphylococcus aureus* shall not exceed $1x10^2$ colonies per gram of sample
- *Salmonella* spp. shall be Absent in 25 gram of chicken meat sample

(Thai Agricultural standard, 2005)

Microbiological Standards for Meat and Meat Products-Philippines

Dried Animal Products				
Staphylococcus (Coagulase+) cfu /g	n = 5	c = 1	m = 10^2	M = 10^4
*Clostridium perfringens*cfu /g	n = 5	c = 1	m = 10^2	M = 10^4
Salmonella/25g	n =10	c = 0	m = 0	
Meat paste and pate				
Salmonella//25g	n = 5	c = 0	m = 0	
Clostridium perfringens cfu /g	n = 5	c = 2	m = 10^2	M = 10^3
Staphylococcus (Coagulase+)cfu /g	n = 5	c = 2	m = 10^2	M = 10^3
Coliforms cfu /g	n = 5	c = 2	m = 10	M = 10^2
SPC/APC cfu /g	n = 5	c = 2	m = 10^4	M = 10^5
Cold cuts, Frozen and chilled Hot Dogs, Luncheon meat				
E.coli MPN/g	n = 5	c = 0	m = 1.8	
Salmonella /25g	n = 10	c = 0	m = 0	
Staphylococcus (Coagulase+)cfu /g	n = 5	c = 2	m = 10^2	M = 10^3
SPC/APC, cfu/g	n = 5	c = 2	m = 10^5	M = 10^6

Microbiological Standards for Meat and Meat Products-Philippines

Packaged cooked cured/salted meat(ham/bacon)				
Staphylococcus(Coagulase+) cfu /g	n = 5	c = 2	m = 10^2	M = 10^3
Salmonella/25g	n =5	c = 0	m = 0	
Listeria monocytogens/25g	n =5	c = 0	m = 0	
Fermented comminuted meat, not cooked (dry and semidry fermented sausage)				
E.coli MPN/g	n = 5	c = 0	m = 1.8	
Staphylococcus (Coagulase+)cfu /g	n = 5	c = 1	m = 10^3	
Salmonella//25g	n = 5	c = 0	m = 0	M = 10^4
Cooked Poultry meat frozen to be reheated before eating				
Staphylococcus (Coagulase+)cfu /g	n = 5	c = 1	m = 10^3	M = 10^4
Salmonella /25g	n = 5	c = 0	m = 0	

Microbiological Standards for Meat and Meat Products-Philippines

Cured/smoked poultry meat				
Staphylococcus (Coagulase+) cfu /g	n = 10	c = 1	m = 10^3	M = 10^4
Salmonella/25g	n =10	c = 0	m = 0	
Dehydrated Poultry products				
Salmonella/25g	n = 19	c = 0	m = 0	
Fresh /Frozen Raw Chicken				
SPC/APC cfu/g	n = 5	c = 3	m = 5x0^5	M = 10^7

(FDA, Philippines, 2013)

Conclusion & Recommendations

- Authority must establish it's laboratory network with accreditation for Microbial Food Safety Compliance.
- There must be strict vigilance over consistent and hyper-contamination points; if possible, legal action.
- Microbial risk assessment studies must be undertaken in collaboration with universities/ Institutions of Repute.
- Product-wise microbial profile must be established.
- On-line system for real-time monitoring of microbial and other physico-chemical hazards in foods shall be established.
- Capacity building with institutes and corporate shall be strengthened.