

Listeria monocytogenes: An emerging foodborne pathogen in Ghana?

K. Tano-Debrah, F.K. Saalia, B. Bediako Amoa, J. Appiah, E. Dogbe and K. Bomfeh

Presented at the University of Ghana's College of Health Sciences annual scientific conference on
the increasing burden of non-communicable diseases in Ghana

Accra, Ghana

21-23 September 2011

INTRODUCTION

Foodborne pathogens

- Foodborne pathogens are disease-causing microorganisms transmitted through food
- Traditionally includes such species of the genera *Salmonella*, *Shigella*, *Escherichia* (Enterotoxigenic *E. coli*) *Campylobacter*, *Clostridium*, *Staphylococcus*, *Streptococcus* (beta type), *Brucella* and *Mycobacterium*

Emerging foodborne pathogens

- Over the last 20-25 years, pathogenic microorganisms have been newly described or have been associated with foodborne outbreaks
- These are pathogens which
 - have increased in prevalence in recent decades or are likely do so in the near future
 - hitherto had not been detected in foods in a given area
 - hitherto had not been implicated in any foodborne illness
 - have been recently detected in foods and/or implicated in foodborne disease outbreaks in a given area

Reasons for emergence

- Increasing preference for 'natural' or 'fresh' foods
- Complex food supply chains with multi-stakeholder participation and increase in potential points of contamination
- Trends towards global sourcing of raw materials in food production
- Increasing international travel/migration
- Advancements in detection and identification of pathogens
- Better reporting and diagnosis of foodborne illnesses

Examples of emerging foodborne pathogens

- **Viruses**

- Hepatitis A and E
- Norovirus
- Avian influenza virus (H5N1)

- **Parasites**

- *Cryptosporidium parvum*
- *Cyclospora cayetanensis*
- *Anisakis* spp.

Examples of emerging food-borne pathogens

Bacteria

- *Campylobacter jejuni*
- *Mycobacterium paratuberculosis*
- *Salmonella* serotypes *enteritidis* and *typhimurium* DT104
- *Yersinia enterocolitica*
- *Listeria monocytogenes*

Listeria monocytogenes

- *L. monocytogenes* is a non-spore forming pathogenic bacterium that causes a highly fatal disease called listeriosis
- It is considered the leading cause of death among foodborne bacterial pathogens, with a fatality rate of 20-30% and up to 75% in highly immunocompromised individuals

Table 1: Fatality of *L. monocytogenes* infection (CDC 2000)

Pathogen	Illnesses	Deaths	% Deaths
<i>Campylobacter</i> spp.	10,539	99	0.95
<i>Salmonella</i> non-typhoidal	15,608	553	3.54
<i>L. monocytogenes</i>	2,298	499	21.71

Table 2: Fatalities of some incidences of listeriosis

Country	Year	Food	Illnesses	Deaths	%Deaths
Finland	1998	Butter	25	24	96
France	2000	Pork meat	32	31	96
USA	2000	Turkey	30	7	23
USA	2002	Turkey	54	11	20
Switzerland	2005	Cheese	11	2	18
Canada	2008	Red meat	53	20	38

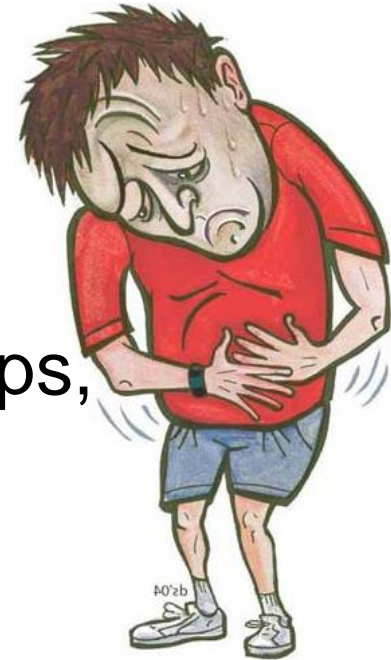
Disease symptoms

- Incubation period of human listeriosis is typically **2-3 weeks**, and up to **three months**
- Systemic transmission of pathogen
- Growth of pathogen in phagocytes

Disease symptoms

Non-invasive infection

- gastroenteritis characterized by chills, headache, diarrhoea, abdominal cramps, nausea, vomiting, fatigue



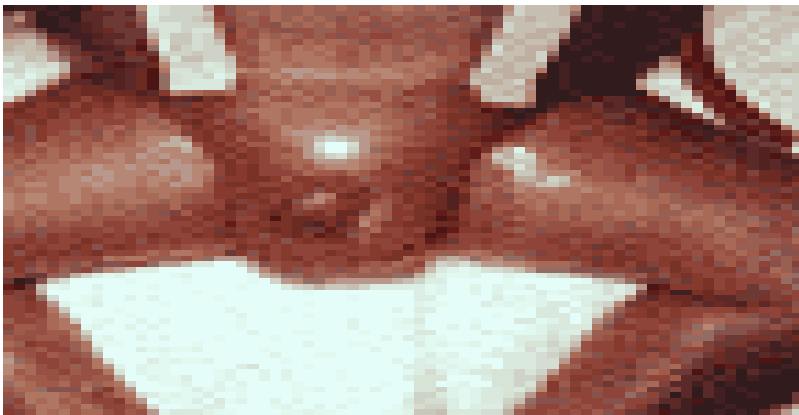
Disease symptoms

Invasive infection

Several clinical manifestations

- meningoencephalitis
- septicemia and abortions
- premature birth
- spontaneous abortions
- still births

Some clinical manifestations of listeriosis



Routes of transmission

- Contaminated food is the principal route of infection in humans
 - estimated to be the source in as high as 99% of listeriosis cases

Foods frequently contaminated

- Milk and milk products
- Soft cheese
- Processed meats, red meat
- Vacuum packaged beef and poultry products
- Lettuce
- Coleslaw
- Fried rice
- Smoked fish
- Salted fish

Occurrence of listeriosis in Ghana

- Human listeriosis is not documented in Ghana. However, the occurrence of the illness among herds of sheep has been reported (Osei-Somuah *et al.* 2000)
- Symptoms suggestive of *L. monocytogenes* infection are also recorded in disease reporting in health facilities
 - Prevalence of meningitis
 - In 2009, >80% of disease cases reported in the district covering Ashiaman where raw milk consumption is high were meningitis
 - In 2008, 73% of monthly disease cases reported in the same district were meningitis
 - Prevalence of spontaneous abortions (Table 1)

Table 1: Abortions recorded at Tema General Hospital in 2008

Month	Type of abortion		
	Spontaneous	Induced	D&Cs
Jan	37	3	40
Feb	33	2	35
Mar	32	2	34
Apr	29	1	30
May	47	5	52
Jun	63	2	65
Jul	80	1	81
Aug	51	3	54
Sep	55	3	58
Oct	48	2	50
Nov	38	2	40
Dec	-	-	-

L. monocytogenes risk assessment studies in Ghana

- Studies to determine the risk of consuming foods from the informal markets in Ghana contaminated with *L. monocytogenes* are ongoing at the Department of Nutrition and Food Science, University of Ghana
- Food commodities covered/being covered are:
 - Raw milk on informal markets (**completed**)
 - Coleslaw in street foods and restaurants (**completed**)
 - Traditionally processed fish on informal markets (**completed**)
 - Fresh cut fruits (**ongoing**)
 - Imported frozen meat (**ongoing**)

Main objectives of studies

1. To determine the presence and concentration of *Listeria monocytogenes* in the products
2. To determine the exposure of consumers to the pathogen through consumption of the products
3. To determine the risk of infection following ingestion of the pathogen

Methodology

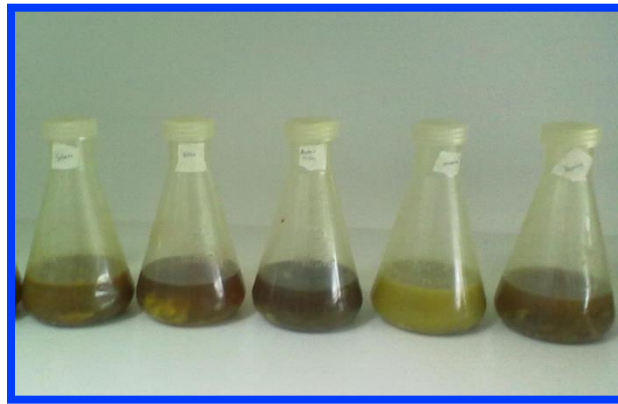
Summary

- Health and consumer surveys
- Commodity sampling and laboratory analysis
- Exposure assessments
- Dose-response assessments
- Risk estimations

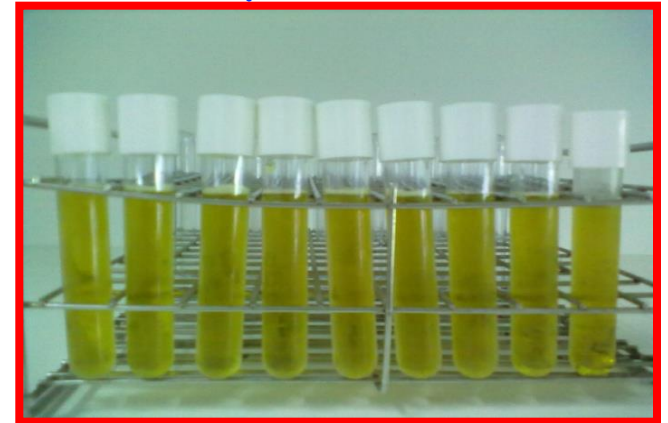
Health and consumer surveys

- Commodity value chains are studied to obtain inputs for risk assessment using
 - Structured questionnaires
 - Focus group discussions
 - Participatory rural appraisals

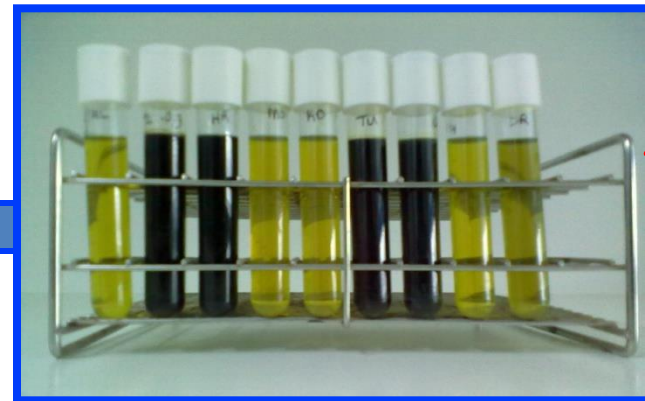
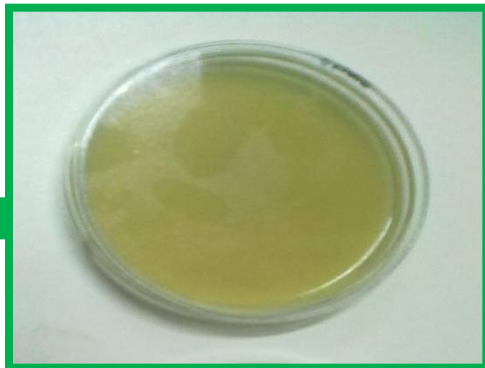
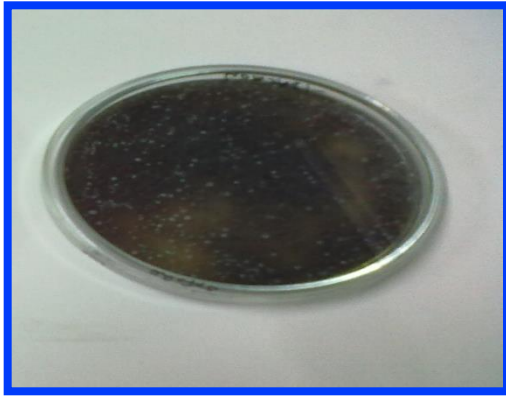
**Primary Enrichment
LEB, 37°C, 24h**



**Secondary Enrichment
Fraser, 37°C, 24-48h**



**Plating on Oxford or
Chromagar, 37°C, 24-28h**



Exposure assessment

- **Prevalence** was determined as the percentage of samples in which the organism was isolated
- **Concentration** was expressed as the colony forming units of *L. monocytogenes* per gram or ml of product
- Likely numbers of *L. monocytogenes* ingested,

$$N = Q \times S$$

Q: quantity/volume often consumed at an instance

C: concentration of *L. monocytogenes* in product

Dose-response

- Weibull-Gamma model was used

$$P_{\text{ill}} = 1 - [1 + (N^b)/\beta]^{-\alpha}$$

P_{ill} = probability of illness

N = dose of *L. monocytogenes* (i.e. likely number ingested)

α , β , b = model parameters

$\alpha=0.25$, $b=2.14$ (Bemrah *et al.*, 1998)

$\beta=10^{10.98}$ for high-risk population

$\beta=10^{15.26}$ for low risk population (Bemrah *et al.*, 1998)

Results and discussion

Key findings

1. *L. monocytogenes* was widely detected in the different food commodity samples analyzed.
2. There are some risks of ingesting *L. monocytogenes* through processed foods on informal markets. However, the risks are low.
3. Sanitary conditions of processing and handling are unsatisfactory and are the potential sources of contaminations
4. Improving hygienic handling of processed foods and appropriately managing of the critical control points in these processes could eliminate these risks.

Milk

Table 1: Prevalence of *Listeria/L. monocytogenes* in milk samples

Sample	1 st Batch		2 nd Batch	
	<i>Listeria</i> sp.	<i>L. monocytogenes</i>	<i>Listeria</i> sp.	<i>L. monocytogenes</i>
Production	84.2%	47.4%	89.5%	42.1%
Retailed	100.0%	84.2%	94.7%	79.0%
Boiled	21.1%	21.1%	26.3%	21.1%
Fermented	73.7%	52.6%	94.7%	84.2%

Milk

Table 2: Likelihood of illness from ingesting milk contaminated with *L. monocytogenes*

Product	Mean probability of illness
Milk at production	1.64×10^{-9}
Milk at retail	1.02×10^{-8}
Boiled milk	1.30×10^{-8}
Fermented milk	5.45×10^{-7}

Coleslaw

Table 3: Prevalence of *L. monocytogenes* in coleslaw

Samples	Number	<i>Listeria</i> colonies tested	<i>L. monocytogenes</i> confirmed
Cabbage	23	115	96 (85.3%)
Coleslaw	58	290	227 (78.3%)

Coleslaw

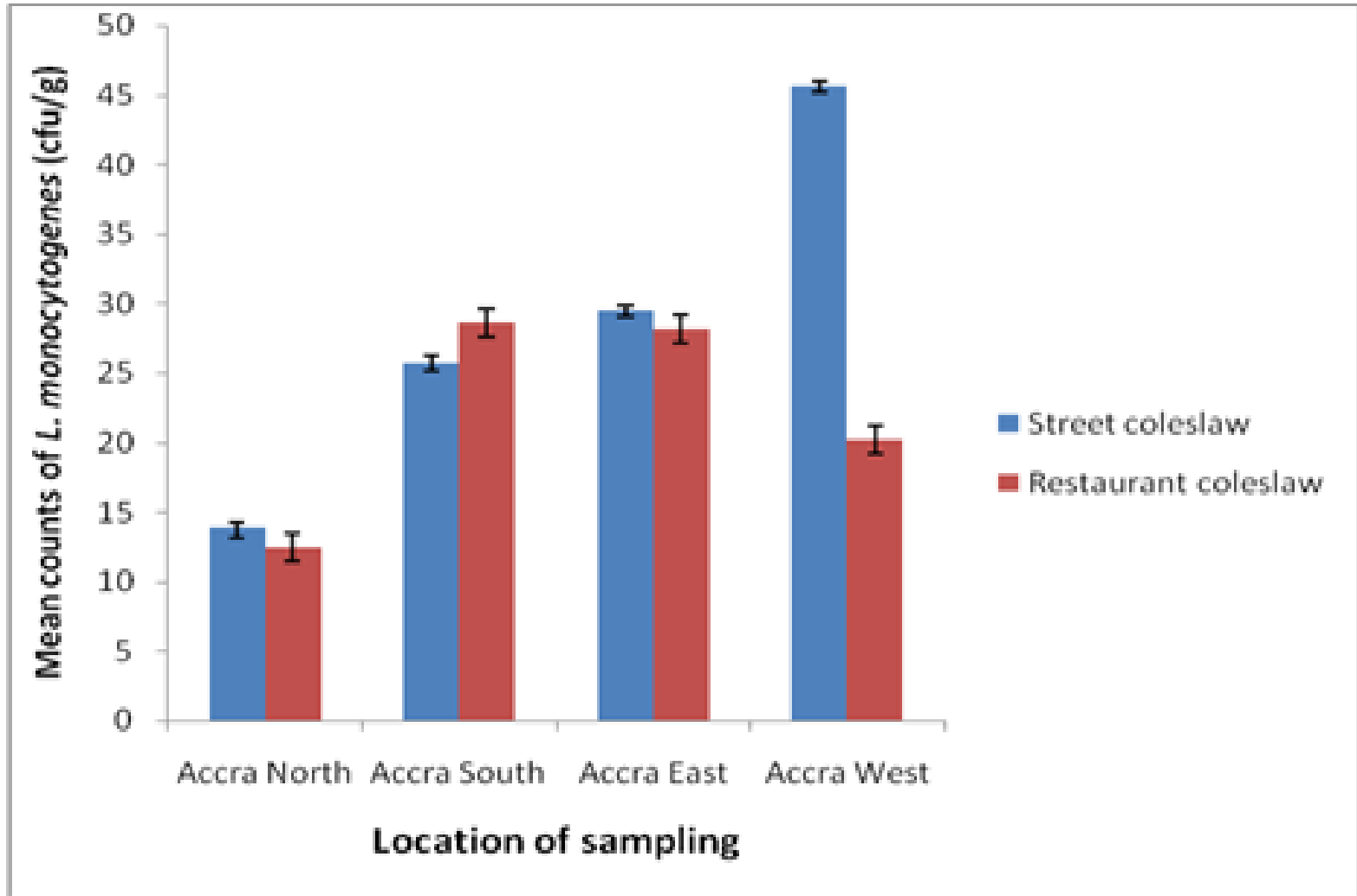


Fig. 1: Load of *L. monocytogenes* in coleslaw samples at consumption point.

Fish

Table 1: Average prevalence of *Listeria monocytogenes* in traditionally processed fish purchased from some informal markets in Accra and Tema

Product	Number of samples purchased	Number of samples positive for <i>L. monocytogenes</i>	Prevalence of <i>L. monocytogenes</i> (%)
Smoked tuna	15	12	80
Smoked mackerel	15	14	93
Smoked herrings	15	10	67
Sundried sardines	15	9	60
<i>Koobi</i>	15	6	40
<i>Kako</i>	15	8	53
<i>Momoni</i>	15	8	53

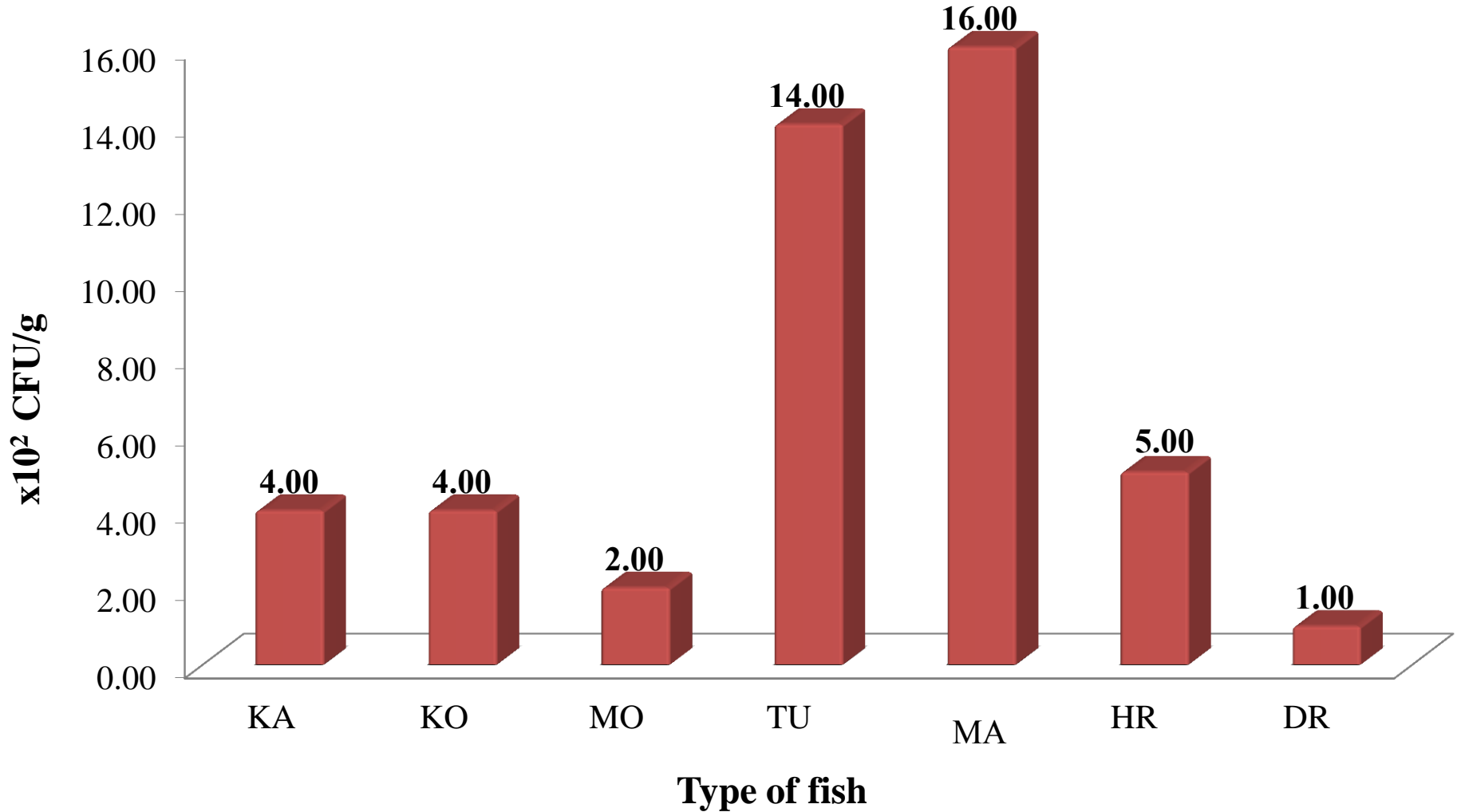


Fig. 1: Average counts of *L. monocytogenes* in fish samples

KA-kako (salted) KO-koobi (salted) MO-momoni (salted)
TU-tuna MA-Mackerel HR-herrings DR-dried fish

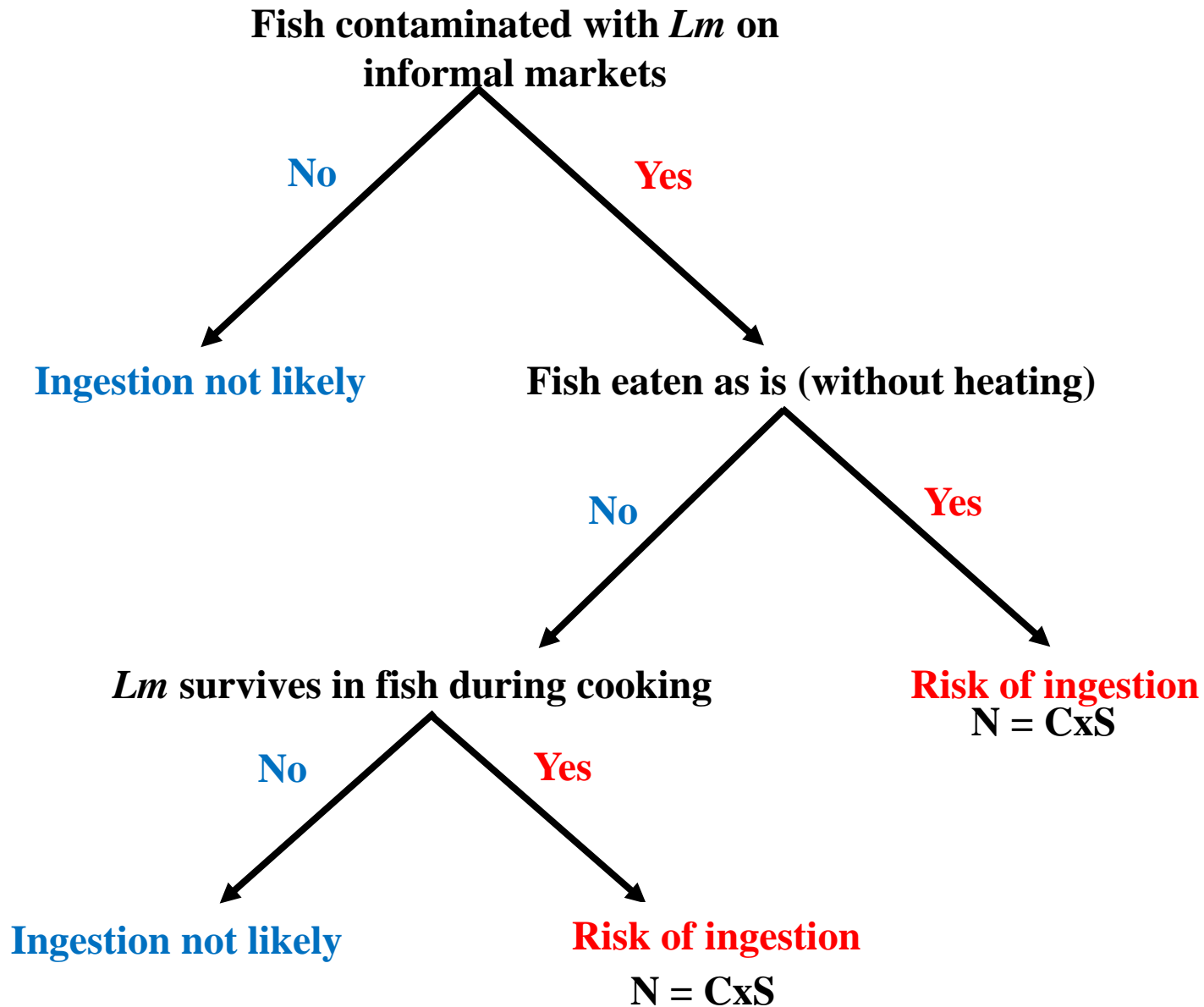


Fig. 2: Event tree for risk of ingestion of *Listeria monocytogenes* through consumption of traditionally smoked fish purchased from informal markets

Table 2: Summary of ranges of probability of illness among consumers (without regard to communities) of traditionally processed fish

Product	Ranges of probability of illness			
	Low Risk Group	High Risk Group		
	Respondents	Elderly	Children	Pregnant women
Smoked Tuna	$10^{-4} - 10^{-7}$	$10^{-1} - 10^{-3}$	$10^{-1} - 10^{-7}$	$10^{-1} - 10^{-2}$
Smoked mackerel	$10^{-3} - 10^{-6}$	$10^{-1} - 10^{-2}$	$10^{-1} - 10^{-2}$	$10^{-1} - 10^{-2}$
Smoked herrings	$10^{-6} - 10^{-8}$	$10^{-1} - 10^{-2}$	$10^{-1} - 10^{-3}$	$10^{-1} - 10^{-5}$
Sundried sardines	$10^{-6} - 10^{-7}$	$10^{-2} - 10^{-3}$	$*10^{-3}$	$*10^{-2}$
<i>Kako</i>	$10^{-8} - 10^{-11}$	$10^{-4} - 10^{-6}$	-	$10^{-4} - 10^{-6}$
<i>Koobi</i>	$10^{-7} - 10^{-8}$	$10^{-3} - 10^{-4}$	-	$10^{-7} - 10^{-8}$
<i>Momoni</i>	$10^{-9} - 10^{-10}$	$10^{-5} - 10^{-9}$	-	$10^{-5} - 10^{-9}$

Milking and milk handling practices make contamination highly probable





Processing and handling of fish: Smoked tuna, herrings and mackerel



Processing and handling of sundried fish



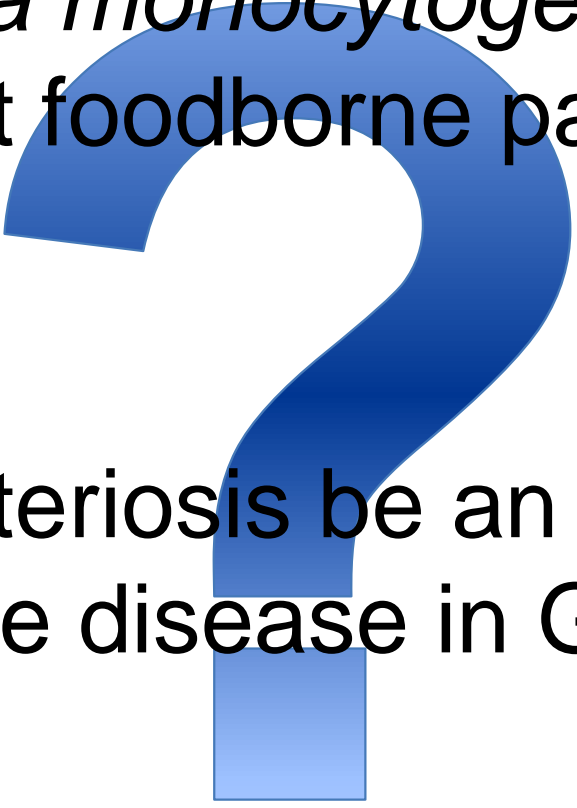
Conclusions

Listeria monocytogenes were isolated from raw milk, coleslaw and traditionally processed fish on informal markets, although in low concentrations

The products are potential vehicles for the transmission of *Listeria monocytogenes*

Symptoms of listeriosis which are also caused by other pathogens are prevalent; however *L. monocytogenes* is not in the list of pathogens of interest in the country

The “big” questions

1. Is *Listeria monocytogenes* a prevalent foodborne pathogen in Ghana?
 2. Could listeriosis be an emerging foodborne disease in Ghana?
- 

Recommendations

- Further studies on the occurrence (prevalence and concentration) of the pathogen in other foods on the Ghanaian (informal) market
- Screening of placental smears for and molecular typing of *L. monocytogenes* to confirm occurrence of listeriosis
- Improvements in the sanitary conditions of traditional food processing
- Optimization of unit operations in traditional food processing, e.g. pasteurization, fermentation and smoking

Thank you