“Antimicrobial Resistance Surveillance Activities (NAHPRI-GDAHP)”

Reviewing Workshop on the implementation of NAP and advancing collaborations in AMR/AMU surveillance/data sharing – Supported by Fleming Fund

presentation by: Dr.Chea Rortana, vice chief office of National Animal Health and Production Research Institute, General Directorate of Animal Health and Production

25-27 March 2025, Sweet Boutique Hotel, Kampot, Cambodia

Content

- 1. Introduction
- 2 Laboratories Capacity
- 3-Antimicrobial Susceptibility Testing
- 4- Technical and Scientific Publications
- 5-AMR Surveillance in animal health

1. Introduction: Draft of National AMR surveillance Plan

តារាងទី ២ៈ បាក់តេរីគោលដៅ

គោលបំណង		ប្រភេទសត្វ	បាក់តេរីគោលដៅ
ទី១	សត្វដែលមានជំងឺ	គោ ក្របី	*Pasteurella multocida, Clostridium chauvoei, Staphylococcus aureus*
		ជ្រូក	*Streptococcus, Salmonella*
		បក្សី	*Pasteurella, Samonella*
ទី២	សត្វដែលមានសុខភាពល្អ	គោ ក្របី	*E.coli, Salmonella, Enterococcus*
		ជ្រូក	*E.coli, Salmonella, Enterococcus*
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ទី៣	ភាវីសត្វដែលមានជំងឺ	កសិដ្ឋានចិញ្ចឹមត្រីទឹកសាប	*Aeromonas hydrophila, Streptococcus iniae, Edwardsiella ictaluri*
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Timeline One Health Established in Cambodia?

August 2023

INTER MINISTRIAL COORDINATION COMMITTEE FOR ONE HEALTH (IMCC) Singed by Prime Minister

TORs endorsed by ONE HEALTH IMCC

SECTORAL ONE HEALTH TECHNICAL WORKING COMMITTEE (MAFF, MOE, MOH) singed by each sectoral Minister

June 2023

FAO-WHO Development Partners

2012

Zoonotic diseases TWG

Member: MAFF, MOH, WHO, FAO, OIE, IPC, WCS

Meeting: Monthly co-chaired by MOH and MAFF

Priority:

- Avian Influenza
- Rabies
- Leptospirosis
- Anthrax
- Other & unknown zoonotic diseases

2012

AMR TWG under Inter-Ministry Coordination Committee

Member: MOH, MAFF, MOE, WHO, FAO, IPC, USCDC, Universities, NGOs involved in medical field

Meeting: Monthly chaired by MOH

2015

Food Safety WG

Member: 6 key ministries: MAFF, MOH, MOC, MOIH, MOT & MOEF

Themes:

- Food Safety Law drafted with the support of FAO and now being finalized at Council Minister before sending to the National Assembly
- SOP on Food and Environmental Specimen Collection in Foodborne-Disease Outbreak Investigation and Response

2019

Wildlife Health Surveillance Network WG

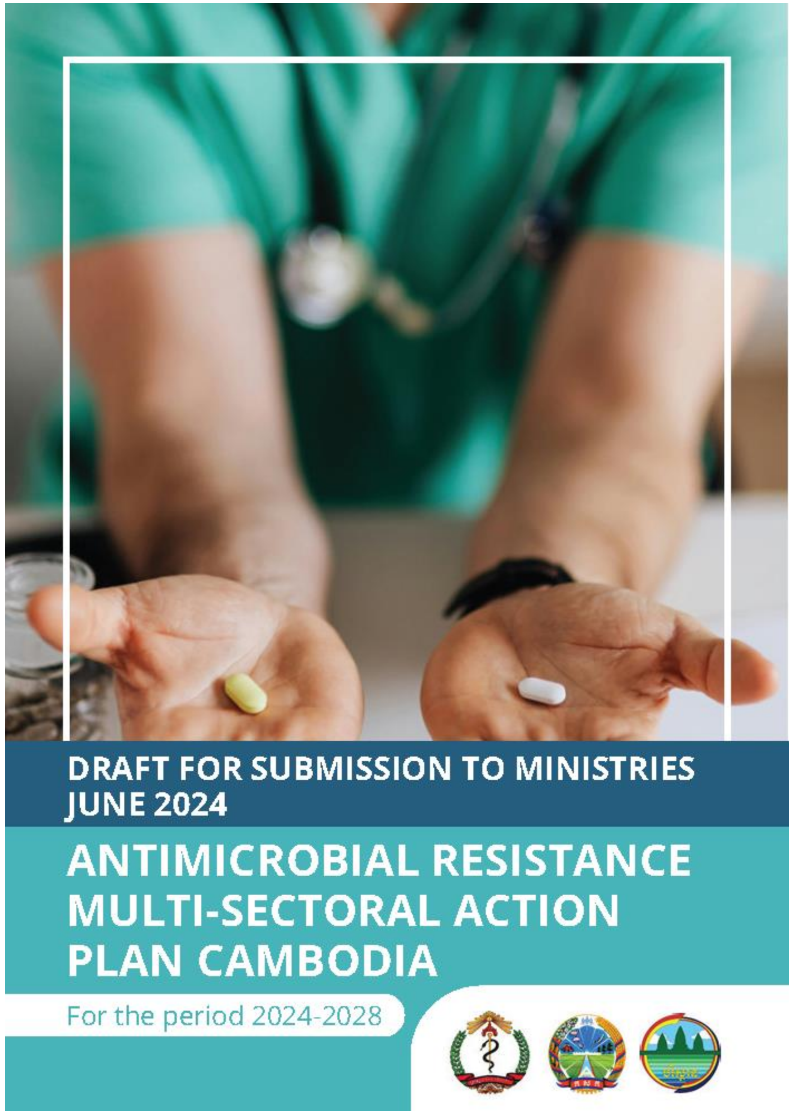
Member: MAFF, MOE, IPC, FAO, US-DTRA, NGOs

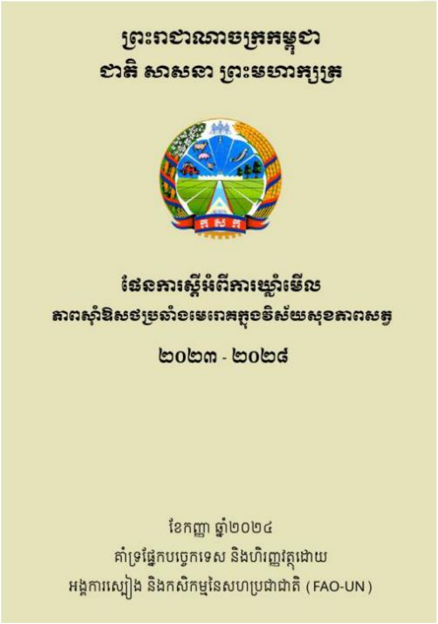
Themes:

- Guide wildlife surveillance activities
- `Facilitate information sharing on wildlife surveillance and outbreak response
- Coordinate capacity building opportunities
- Finalize an SOP for wildlife surveillance in Cambodia

AMR National Surveillance Plan Finalization Workshop

Multi-Sectoral Action Plan on AMR in Cambodia





ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

ផែនការស្តីអំពីការឃ្លាំមើល
ភាពស៊ាំឱសថប្រឆាំងមេរោគក្នុងវិស័យសុខភាពសត្វ
២០២៣ - ២០២៨

ខែកញ្ញា ឆ្នាំ២០២៤
គាំទ្រផ្នែកបច្ចេកទេស និងហិរញ្ញវត្ថុដោយ
អង្គការស្បៀង និងកសិកម្មនៃសហប្រជាជាតិ (FAO-UN)

តារាងទី ២៖ បាក់តេរីគោលដៅ

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2 Laboratories Capacity

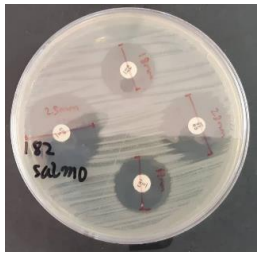
NAHPRI's Bacteriology Lab can perform AST, with the standard method, harmonized in ASEAN

AST:

- Disk diffusion
- Agar dilution
- Microdilution

References: CLSI

NAHPRI's Bacteriology Lab also sharing technique and skill on AMR to other universities and institutions



Using harmonized ASEAN animal health protocols for AMR monitoring

Bacteria isolate training to PNIA staff & student

AST training to RUA staff & student

AST training to KNIA staff & student

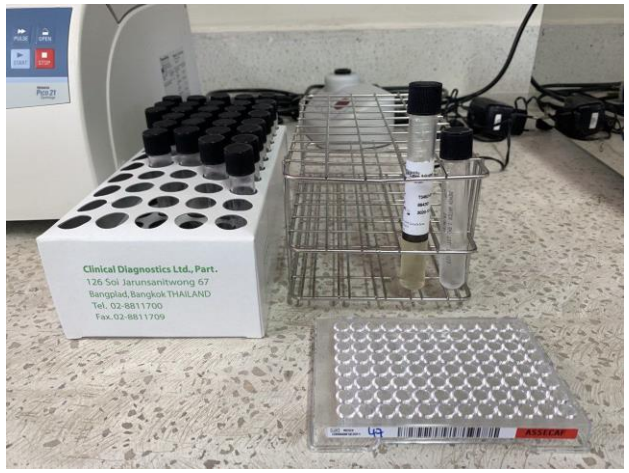
3-Antimicrobial Susceptibility Testing

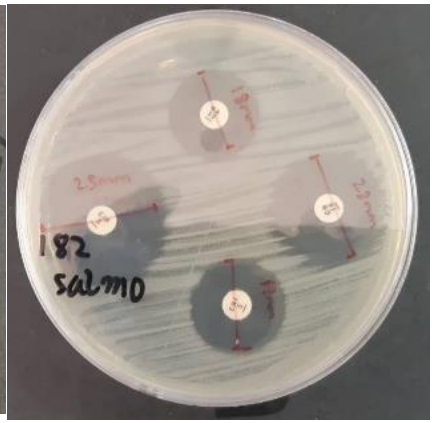
AST:

- Disk diffusion
- Agar dilution
- Microdilution

References:

- CLSI (Clinical Lab Standard Institute)





Antibiotic Susceptibility Testing protocol

AST:

- Disk diffusion
- Agar dilution
- Microdilution

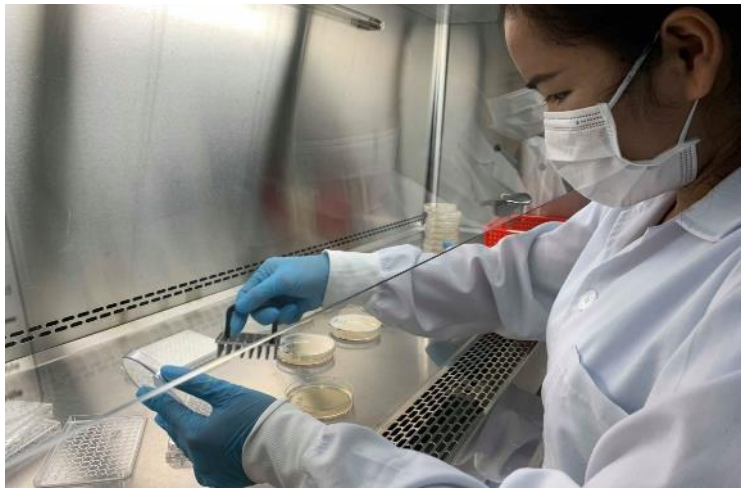
References:

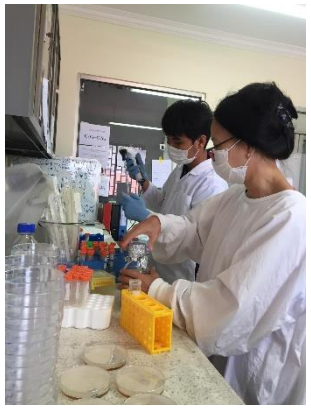
- CLSI
- EUCAST

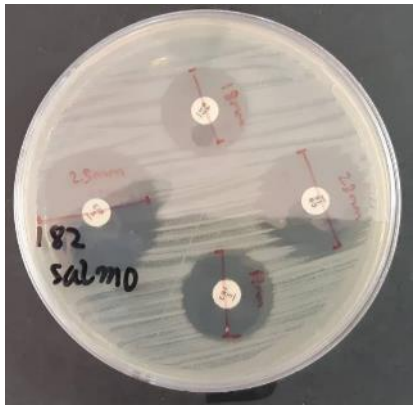
Reference strains:

- *E. coli*
- *S. aureus*
- *P. aeruginosa*

Using harmonized ASEAN animal health protocols for AMR monitoring







4- Technical and Scientific Publications

The 1st National Conference on AMR in Cambodia 2019

GDAHP-NAHPRI's newsletters

NAHPRI's join research with SLU, Sweden

Ström et al. Antimicrobial Resistance and Infection Control (2018) 7:35
https://doi.org/10.1186/s13756-018-0328-y

Antimicrobial Resistance and Infection Control

RESEARCH — Open Access

Antimicrobials in small-scale urban pig farming in a lower middle-income country – arbitrary use and high resistance levels

G. Ström[1], S. Boqvist[2], A. Albihn[2,3], L-L. Fernström[2], A. Andersson Djurfeldt[4], S. Sokerya[5], T. Sothyra[6] and U. Magnusson[1*]

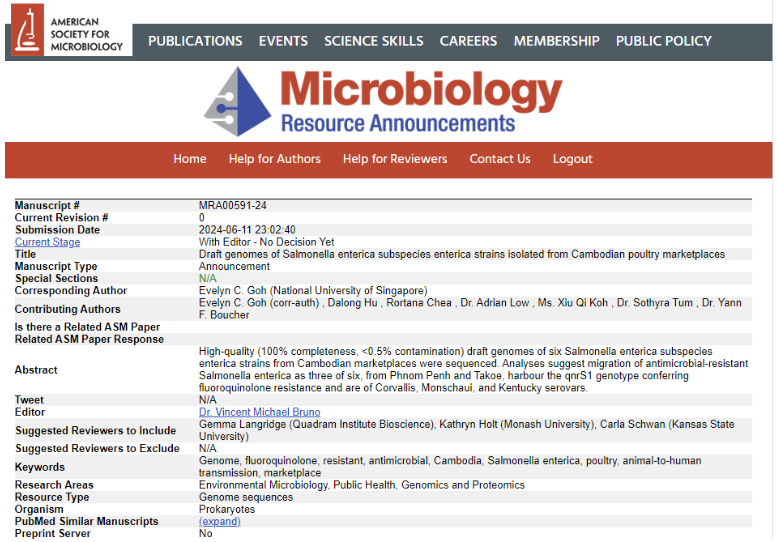
Abstract

Background: Administration of antimicrobials to food-producing animals is regarded as a major contributor to the overall emergence of resistance in bacteria worldwide. However, few data are available on global antimicrobial use and resistance (AMR) in livestock, especially from low- and middle-income countries.

Methods: We conducted a structured survey of 91 small-scale pig farms in the urban and peri-urban areas of Phnom Penh, Cambodia, to assess the farmers' knowledge, attitudes and practices related to antimicrobial use in their pig production. Commensal Escherichia coli was isolated from three healthy pigs from each farm (n = 261) and susceptibility testing was performed against 14 antimicrobials, using broth microdilution. Univariable logistic regression and generalized linear mixed models were used to investigate potential associations between farm characteristics, management factors and resistance to different types of antimicrobials.

Results: We found a widespread and arbitrary use of antimicrobials, often based on the farmer's own judgment. Around 66% of the farmers reported frequently self-adjusting treatment duration and dosage, and 45% had not

NAHPRI's join research with NUS, Singapore



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Manuscript #	MRA00591-24
Current Revision #	0
Submission Date	2024-06-11 23:02:40
Current Stage	With Editor - No Decision Yet
Title	Draft genomes of Salmonella enterica subspecies enterica strains isolated from Cambodian poultry marketplaces
Manuscript Type	Announcement
Special Sections	N/A
Corresponding Author	Evelyn C. Goh (National University of Singapore)
Contributing Authors	Evelyn C. Goh (corr-auth) , Dalong Hu , Rortana Chea , Dr. Adrian Low , Ms. Xiu Qi Koh , Dr. Sothyra Tum , Dr. Yann F. Boucher
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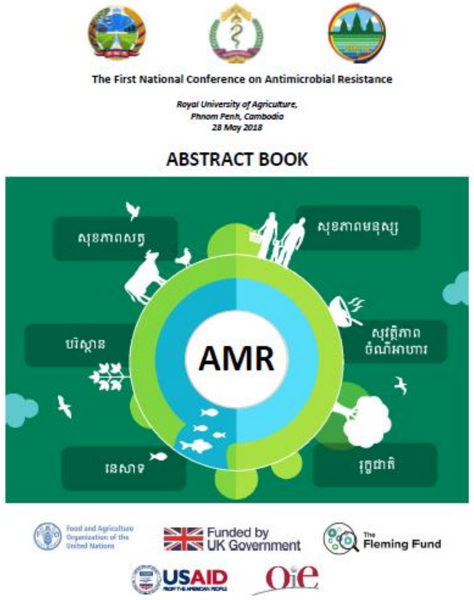
Tweet	N/A
Editor	Dr. Vincent Michael Bruno
Suggested Reviewers to Include	Gemma Langridge (Quadram Institute Bioscience), Kathryn Holt (Monash University), Carla Schwan (Kansas State University)
Suggested Reviewers to Exclude	N/A
Keywords	Genome, fluoroquinolone, resistant, antimicrobial, Cambodia, Salmonella enterica, poultry, animal-to-human transmission, marketplace
Research Areas	Environmental Microbiology, Public Health, Genomics and Proteomics
Resource Type	Genome sequences
Organism	Prokaryotes
PubMed Similar Manuscripts	(expand)
Preprint Server	No

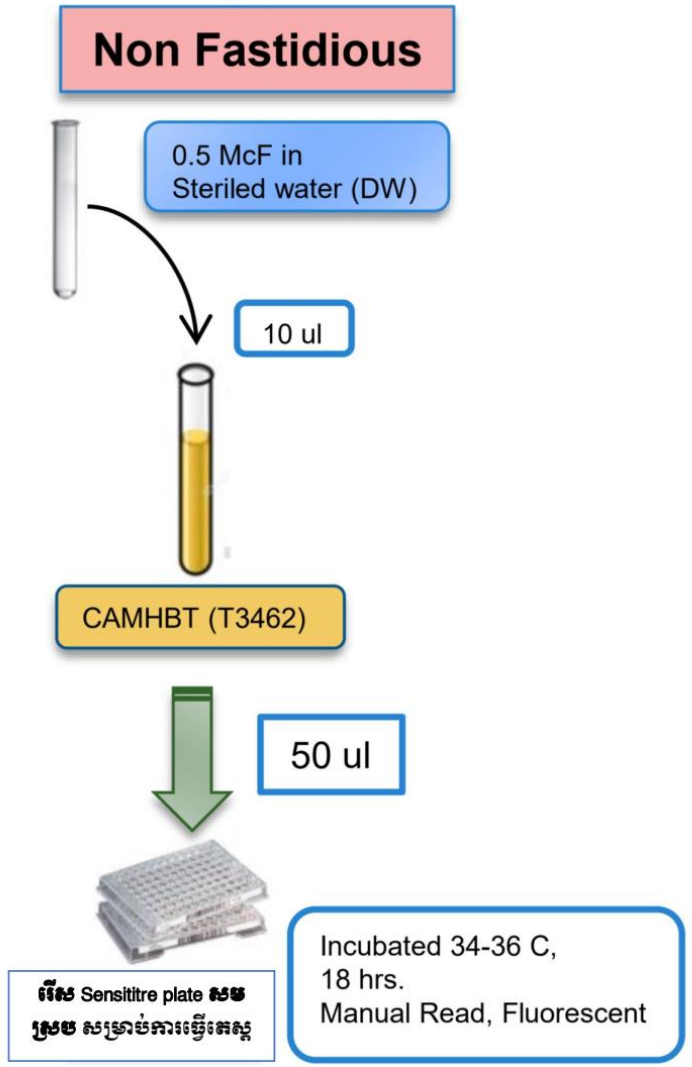


លទ្ធផវិធីស្តែវិភាគប្រសិទ្ធភាពឱសថប្រឆាំងមេរោគ

- Method: CLSI-VET-03, CLSI-VET-04, M45-3A.
- Interpretation

RIS, WT & NWT

	1	2	3	4	5	6	7	8	9	10	11	12
a	AMP 0.015	AMP 0.03	AMP 0.06	AMP 0.12	AMP 0.25	AMP 0.5	AMP 1	AMP 2	AMP 4	AMP 8	AMP 16	MERO 0.008
b	TAZ 0.03	TAZ 0.06	TAZ 0.12	TAZ 0.25	TAZ 0.5	TAZ 1	TAZ 2	TAZ 4	ERY 0.015	ERY 0.5	ERY 1	MERO 0.015
c	GEN 0.06	GEN 0.12	GEN 0.25	GEN 0.5	GEN 1	GEN 2	GEN 4	GEN 8	ERY 0.03	ERY 0.25	ERY 2	MERO 0.03
d	SXT 0.008/0.15	SXT 0.015/0.3	SXT 0.03/0.6	SXT 0.06/1.19	SXT 0.12/2.38	SXT 0.25/4.75	SXT 0.5/9.5	SXT 1/19	ERY 0.06	ERY 0.12	ERY 4	MERO 0.06
e	OXY 0.015	OXY 0.03	OXY 0.06	OXY 0.12	OXY 0.25	OXY 0.5	OXY 1	OXY 2	OXY 4	OXY 8	ERY 8	MERO 0.12
f	ENRO 0.0005	ENRO 0.001	ENRO 0.002	ENRO 0.004	ENRO 0.008	ENRO 0.015	ENRO 0.03	ENRO 0.06	ENRO 0.12	ENRO 0.25	ERY 16	MERO 0.25
g	FFN 0.03	FFN 0.06	FFN 0.12	FFN 0.25	FFN 0.03	FFN 0.03	FFN 0.03	FFN 0.03	FFN 0.03	FFN 0.03	ERY 32	MERO 0.5
h	OXO 0.002	OXO 0.004	OXO 0.008	OXO 0.015	OXO 0.03	OXO 0.06	OXO 0.12	OXO 0.25	OXO 0.5	OXO 1	NEG	POS



5-AMR Surveillance in animal health

1. Assessing the link between the circulation of antimicrobial-resistant organisms in animals and human health in Cambodia (NUS & NAHPRI), on going
    1. - Pathogens: *E.coli, Salmonella and Klebsiella pneumonia*
    2. - Isolation, AST and Whole Genome sequence
2. **AMR surveillance in *Pasteurella multocida* in cattle in Cambodia**
3. Antimicrobial resistance in *Salmonella* and *E. coli* in pork and beef in Cambodian slaughterhouses (EU-PGA-L) 2017 (a polit project)
4. - Antimicrobial resistance in *E. coli* in caecal contain of pigs from Cambodian slaughterhouses (FAO, GCP/GLO/710 project) 2017 (completed)
5. - Prevalence of antimicrobial resistance in *Escherichia coli* and *Salmonella* species isolated from caecal contain of chicken in Cambodia market, 2018 (Government program) completed
6. **Antimicrobial resistance in *Aeromonas hydrophilia* isolated from fish in Cambodia (FiA & FAO & NAHPRI)**
7. AMR surveillance in E.coli and Salmonella from chicken and pig farm

5.1.

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Research Areas	Environmental Microbiology, Public Health, Genomics and Proteomics
Resource Type	Genome sequences
Organism	Prokaryotes
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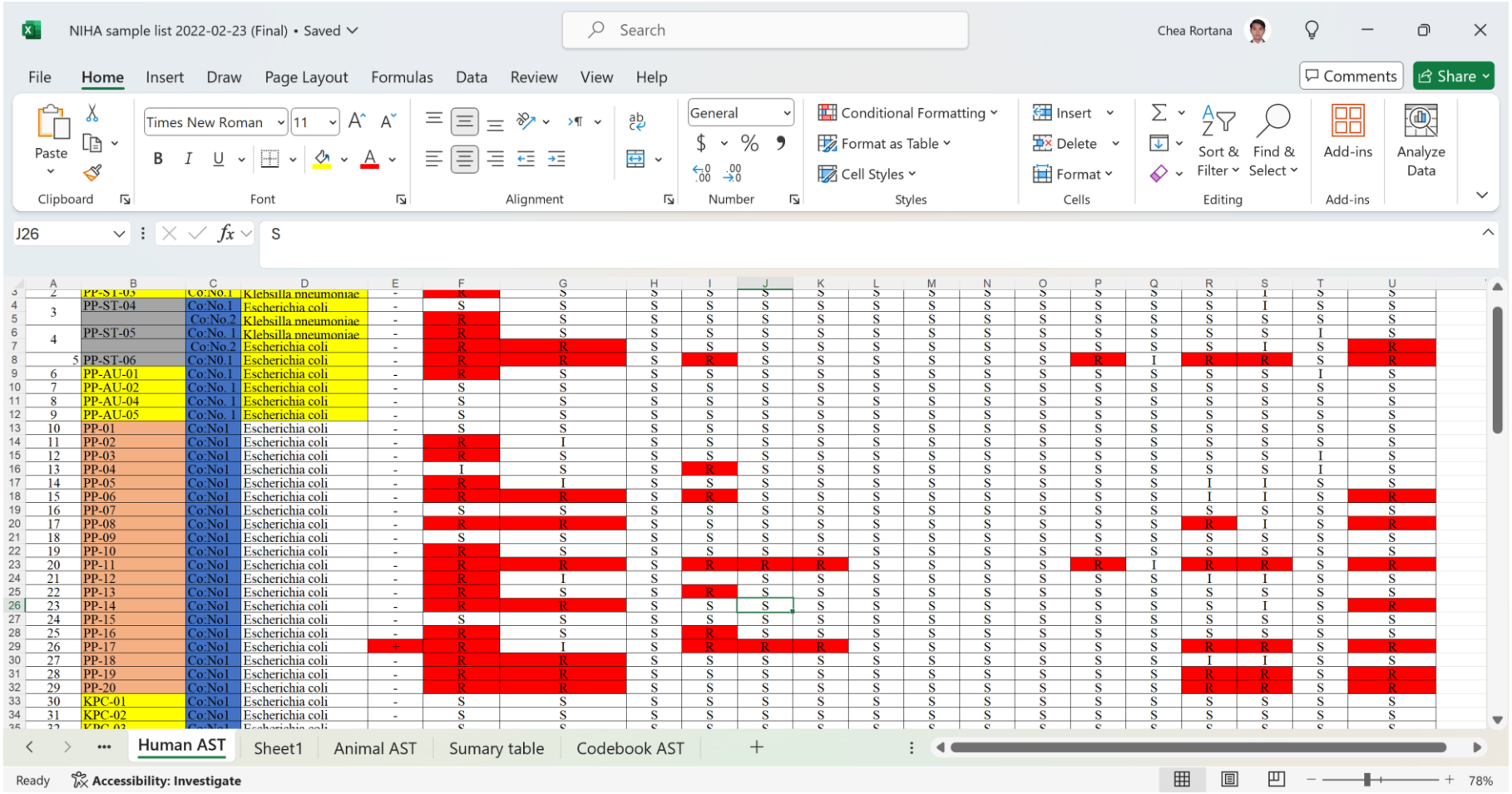
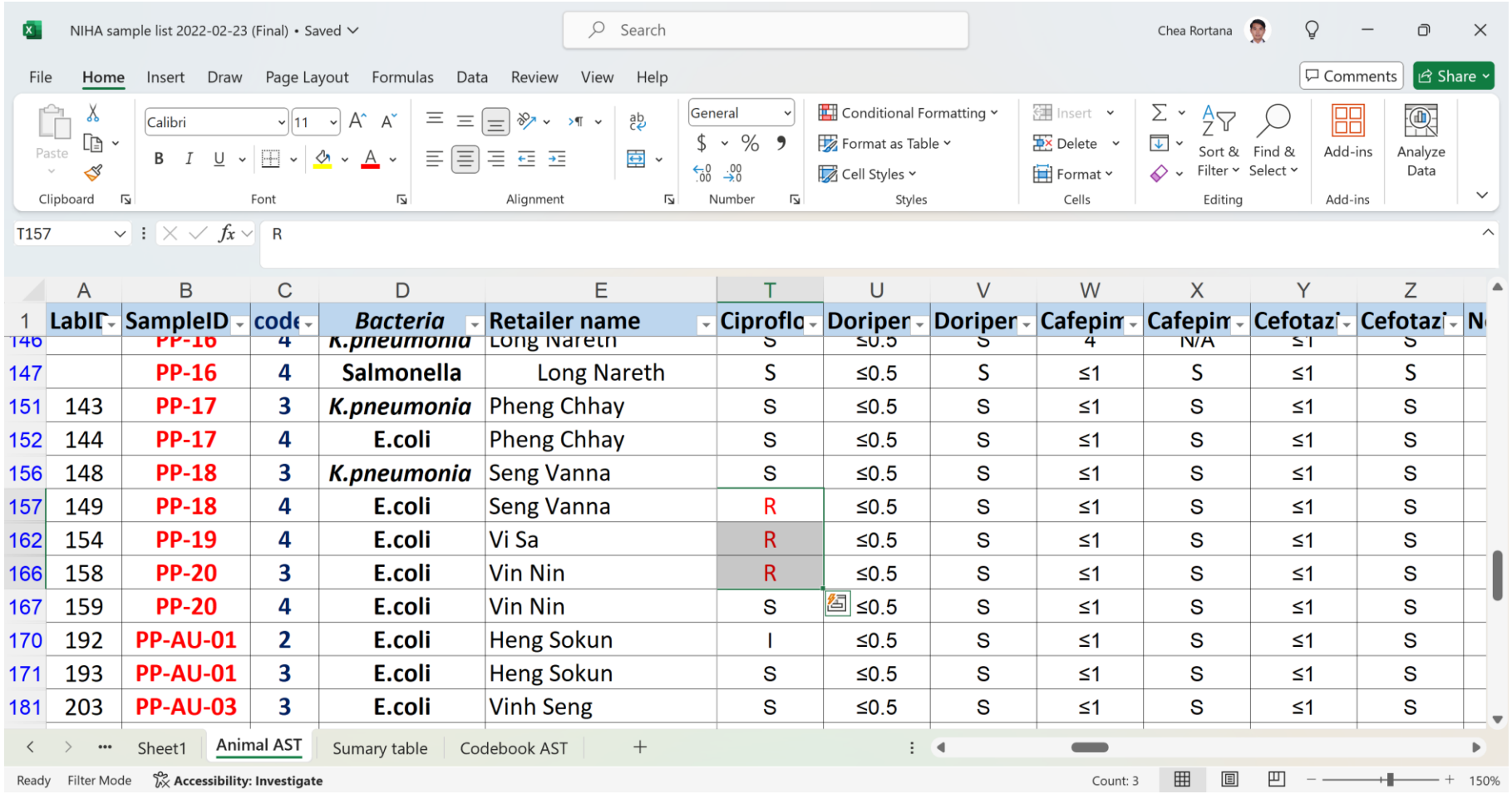
5.1. Result from Human Pool Sample



5.1. Result from Animal Sample



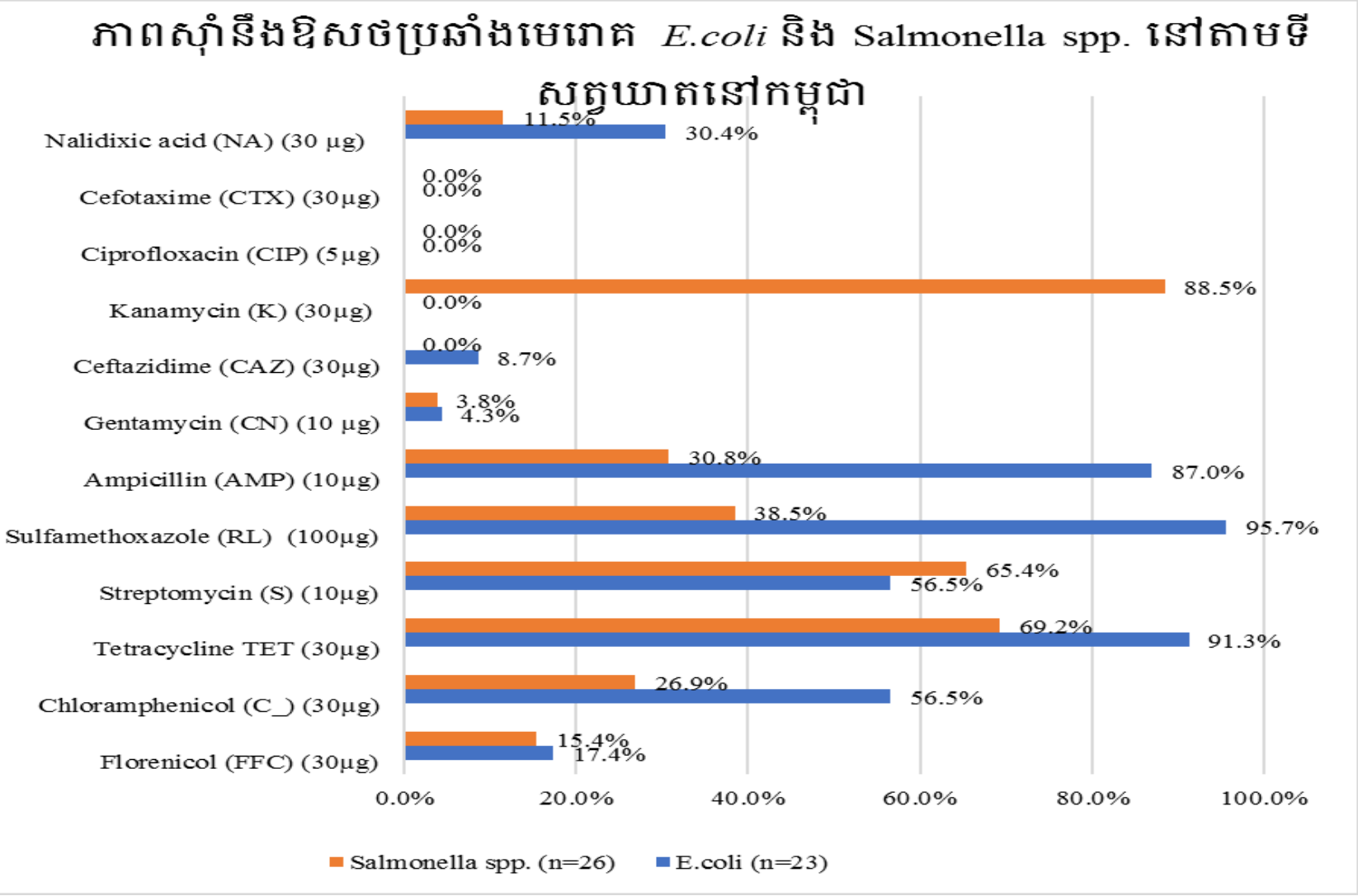
NIHA sample list 2022-02-23 (Final) • Saved

	A	B	C	D	E	T	U	V	W	X	Y	Z
1	LabID	SampleID	code	*Bacteria*	Retailer name	Ciproflo	Doriper	Doriper	Cafepim	Cafepim	Cefotazi	Cefotazi
146		PP-16	4	*K.pneumonia*	Long Nareth	S	≤0.5	S	4	N/A	≤1	S
147		PP-16	4	Salmonella	Long Nareth	S	≤0.5	S	≤1	S	≤1	S
151	143	PP-17	3	*K.pneumonia*	Pheng Chhay	S	≤0.5	S	≤1	S	≤1	S
152	144	PP-17	4	E.coli	Pheng Chhay	S	≤0.5	S	≤1	S	≤1	S
156	148	PP-18	3	*K.pneumonia*	Seng Vanna	S	≤0.5	S	≤1	S	≤1	S
157	149	PP-18	4	E.coli	Seng Vanna	R	≤0.5	S	≤1	S	≤1	S
162	154	PP-19	4	E.coli	Vi Sa	R	≤0.5	S	≤1	S	≤1	S
166	158	PP-20	3	E.coli	Vin Nin	R	≤0.5	S	≤1	S	≤1	S
167	159	PP-20	4	E.coli	Vin Nin	S	≤0.5	S	≤1	S	≤1	S
170	192	PP-AU-01	2	E.coli	Heng Sokun	I	≤0.5	S	≤1	S	≤1	S
171	193	PP-AU-01	3	E.coli	Heng Sokun	S	≤0.5	S	≤1	S	≤1	S
181	203	PP-AU-03	3	E.coli	Vinh Seng	S	≤0.5	S	≤1	S	≤1	S

5.2. AMR surveillance in *Pasteurella multocida* in cattle in Cambodia

- Sample from outbreak of HS around counties,
- Isolation using Culture and API20E
- AST method: Broth microdilution method, using CLSI,
- Up to present: there is about 20 positive isolates and AST was performed.

5.4- Antimicrobial resistance in *Salmonella* and *E. coli* in pork and beef in Cambodian slaughterhouses (EU-PGA-L) 2017 (a polit project



5.3-Antimicrobial resistance in *Aeromonas hydrophilia* isolated from fish in Cambodia (FiA & FAO & NAHPRI)

Objectives:

1. Improve knowledge and capacities on AMU and AMR in Cambodian aquaculture and strengthen AMR-relevant collaboration between terrestrial and aquatic animal sectors in Cambodia
2. Establish coordination between the National Animal Health and Production Research Institute (NAHPRI), the FAO's reference laboratory on AMR for Cambodia, and the Fisheries Administration (FiA) as a preparatory study for future national surveillance in aquaculture.

- The cross-sectional survey was conducted in **Kandal, Kampong Cham, Prey Veng and Pursat provinces** with the objectives:

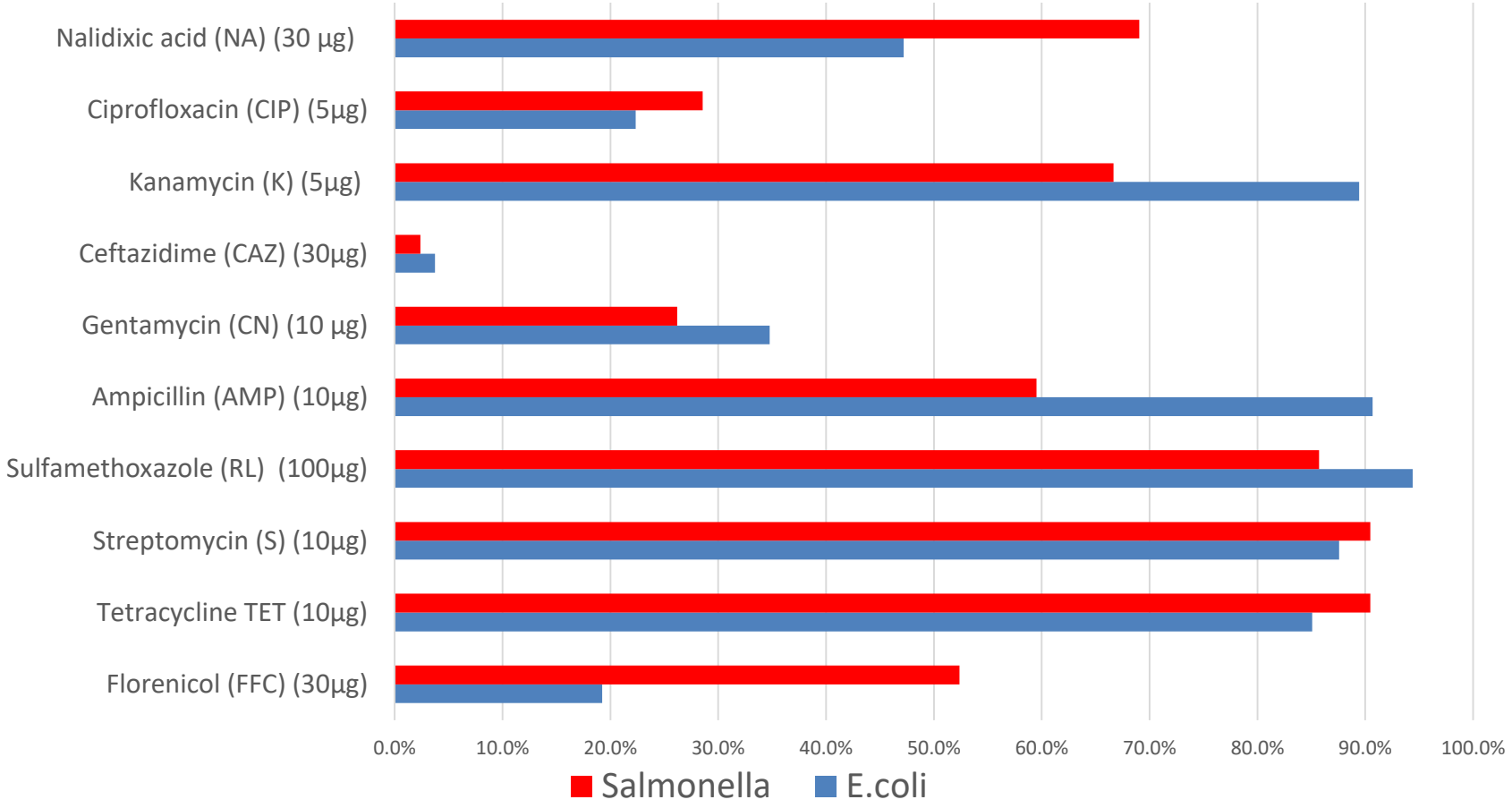
1. To collect baseline data of the Knowledge, Attitude and Practices (mini-KAP) on Antimicrobial use (AMU) and AMR in aquaculture in the studied provinces.
2. To collect biological samples from striped catfish (*Pangasius hypophthalmus)*, diagnose and identify the presence of *Aeromonas hydrophila* in aquaculture ponds/farms in the four targeted provinces to be preserved for further susceptibility testing of *A. hydrophila* to commonly used antibiotics in aquaculture in Cambodia.

2- Table 12. Epidemiological Cut-off profile of the isolates *A.hydrophilia* isolated from the 4 provinces.

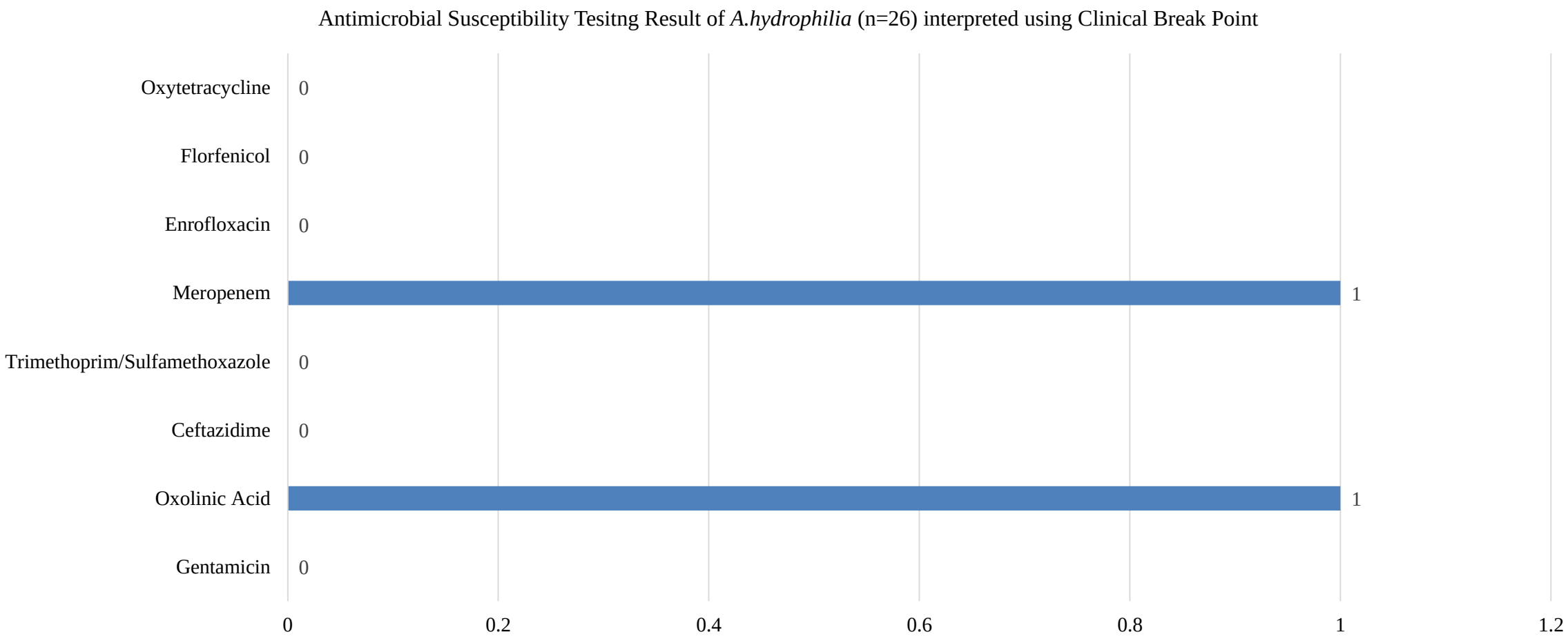
Note: WT= wile type; NWT= non-wild type

	N positive A.hydrophilia	Profile	Gentamicin	Oxolinic Acid	Enrofloxacin	Florfenicol	Oxytetracycline
Overall	26	WT	26	18	25	26	24
		NWT	0	8	1	0	2
Kampong Cham	3	WT	3	0	2	3	3
		NWT	0	3	1	0	0
Prey Veng	5	WT	4	1	5	5	3
		NWT	1	4	0	0	2
Kandal	12	WT	12	11	12	12	12
		NWT	0	1	0	0	0
Pursat	6	WT	6	6	6	6	6
		NWT	0	0	0	0	0

5.6- Prevalence of antimicrobial resistance in *Escherichia coli* and *Salmonella* species isolated from caecal contain of chicken in Cambodia market, 2018 (Government program) completed



AST Results from the 4 provinces in aquaculture



5.3- Assessing the link between the circulation of antimicrobial-resistant organisms in animals and human health in Cambodia (NUS & NAHPRI), on going

	Antimicrobial agent in sensititire (THAN 2F)	Test range (µg/mL)	Sensitive	Intermediate	Resistance
1	Amikacine (AMI)	8-32	≤16	32	≥64
2	Ampicillin (AMP)	8-16	≤8	16	≥32
3	Doripenem (DOR)	0.5-16	≤1	2	≥4
4	Cafepime (FEP)	1-32	≤2		≥16
5	Cefotazime (FOT)	1-32	≤1	2	≥4
6	Cefoxitin (FOX)	4-16	≤8	16	≥32
7	Ceftriaxone (AXO)	05-32	≤1	2	≥4
8	Cefuroxime (FUR)	8-16	≤8	16	≥32
9	Ceftazidime (TAZ)	1-32	≤4	8	≥16
10	Imepenem (IMI)	0.5-16	≤1	2	≥4
11	Meropenem (MERO)	0.5-16	≤1	2	≥4
12	Gentamicin (GEN)	2-8	≤4	8	≥16
13	Levofloxacin (LEVO)	0.06-8	≤0.12	0.25-1	≥2
14	Ciprofloxacin (CIP) (For Salmonella)	0.06-2	≤0.06	0.12-0.5	≥1
15	Ciprofloxacin (CIP) (for E.coli)	0.06-2	≤0.25	0.5	≥1
16	Piperacilin/tazobactam contant4 (P/T4)	8/4-64/4	≤16/4	32/4-64/4	≥128/4
17	Ertapenem (ETP)	0.5-4	≤0.5	1	≥2
18	Trim/ethoprim/sulfamethoxazole (SXT)	1/19-4/76	≤2/38	-	≥4/76
19	Netilmicin (NET)	8-16	≤8	16	≥32
20	Colistin (COL)	1-8	≤2	-	≥4
21	Ampicillin/sulbactam 2:1 ratio (A/S2)	4/2-16/8	≤8/4	16/8	≥32/16
22	Amoxicillin / clavulanic acid 2:1 ratio (AUG2)	4/2-16/8	≤8/4	16/8	≥32/16

Number of Positive Isolates from (n=250)

Bacteria species	Number of positive
E.coli	106
Klebsiella pneumoniae	23
Salmonella	7

Number of Positive Isolates, species and provinces

		SUM of Salmonella	SUM of K.pneumonia	SUM of E.coli
Kampong Speu	chicken cloaca	0	0	8
	environment	0	0	7
	human faecal	0	0	8
	Meat	0	0	0
	no sample			
	Shop+ cage	0	0	3
Kampong Speu Total		0	0	26
Phnom Penh	chicken cloaca	3	3	21
	environment	0	6	7
	human faecal	0	2	27
	Meat	1	2	1
	no sample			
	Shop+ cage	1	3	5
Phnom Penh Total		5	16	61
Takoe	chicken cloaca	0	0	4
	environment	0	0	3
	human faecal	0	3	7
	Meat	2	0	1
	no sample	0	0	0
	Shop+ cage	0	2	3
Takoe Total		2	5	18
Grand Total		7	21	105

5.4- Antimicrobial resistance in *E. coli* in caecal contain of pigs from Cambodian slaughterhouses (FAO, GCP/GLO/710 project) 2017, n= 497

Susceptibility	Clinical Break Point	Susceptible (%)		Intermediate (%)		Resistance (%)	
Ampicillin	≥32	25	(5.2)	1	(0.2)	459	(94.6)
Azithromycin	N/A	N/A		N/A		N/A	
Cefotaxime	≥4	352	(72.6)	12	(2.5)	119	(24.5)
Ceftazidime	≥16	408	(84.1)	28	(5.8)	48	(9.9)
Chloramphenicol	≥32	51	(10.5)	27	(5.6)	407	(83.9)
Ciprofloxacin	≥4	313	(64.5)	25	(5.2)	147	(30.3)
Colistin	N/A	N/A	N/A	-	-	N/A	N/A
Gentamicin	≥16	343	(70.7)	7	(1.4)	135	(27.8)
Meropenem	≥4	482	(99.4)	2	(0.4)	1	(0.2)
Nalidixic acid	≥32	279	(57.5)	0		206	(42.5)
Sulfamethoxazole	≥512	11	(2.3)	0		474	(97.7)
Streptomycin	N/A	N/A			N/A	N/A	
Tetracycline	≥16	27	(5.6)	3	(0.6)	455	(93.8)
Trimethoprim	≥16	67	(13.8)		(0.0)	418	(86.2)
Tigecycline	N/A	N/A		N/A		N/A	

Support by: FAO throug AMR Fleming Fund

5.5- AMR surveillance in Pig Slaughterhouse -2018-2020

Table 4. Distribution of minimum inhibition concentration (MIC µg/mL) for the 15 tested antimicrobials against *E.coli* (n=485)

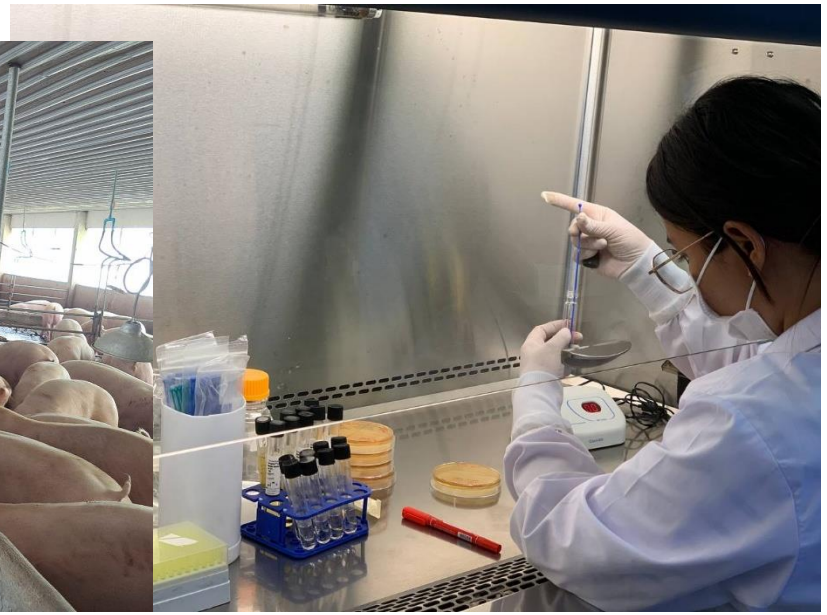
MIC distribution	Ampicillin	Azithromycin	Cefotaxime	Ceftazidime	Chloramphenicol	Ciprofloxacin	Colistin	Gentamicin	Tigecycline	Nalidixic acid	Streptomycin	Tetracycline	Meropenem	Sulfamethoxazole	Trimethoprim
0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.015	-	-	-	-	-	59	-	-	-	-	-	-	87	-	-
0.03	-	-	-	-	-	30	-	-	-	-	-	-	287	-	-
0.06	-	-	240	-	-	5	-	-	-	-	-	-	48	-	-
0.12	-	-	82	66	-	22	10	-	-	-	-	-	26	-	-
0.25	-	-	12	209	-	64	182	6	253	-	-	-	8	-	25
0.5	2	0	13	86	-	103	104	46	128	-	-	-	19	-	37
1	2	2	7	13	0	30	48	189	1	0	1	5	7	0	7
2	5	10	12	11	0	25	24	65	29	56	0	10	2	1	3
4	14	157	27	21	10	17	10	37	24	104	4	12	0	4	2
8	2	133	18	31	41	19	31	7	26	82	34	3	1	6	3
16	1	68	74	29	27	111	76	8	24	39	34	5	-	3	2
32	2	31	-	19	40	-	-	25	-	6	81	9	-	0	-
64	3	84	-	-	93	-	-	41	-	15	79	98	-	0	1
128	454	-	-	-	83	-	-	61	-	183	57	289	-	0	1
256	-	-	-	-	191	-	-	-	-	-	195	54	-	2	404
512	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
1024	-	-	-	-	-	-	-	-	-	-	-	-	-	467	-
Resistance Profiles (frequency)	459 (94.6%)		119 (24.5%)	48 (9.9%)	407 (83.9%)	147 (30.3%)		124 (25.6%)		204 (42.1%)		455 (93.8%)	1 (0.2%)	469 (96.7%)	408 (84.1%)

Note: The AST of *E. coli* were performed using regionally-customized broth microdilution plates which followed dilution ranges largely based on the Regional AMR monitoring and surveillance guidelines volume 1: Monitoring and Surveillance of AMR in bacteria in healthy animals intended for consumption (http://www.fao.org/3/ca6897en/ca6897en.pdf)

5.7 Pilot AMR surveillance in E.coli and Salmonella in chicken and pig in 3 provinces of Cambodia (2024)

Biosecurity Preparation before entering to the farm for sample collection in Pig Farm in Kampong Cham

Performing AST testing in Laboratory	Reading result from AST test



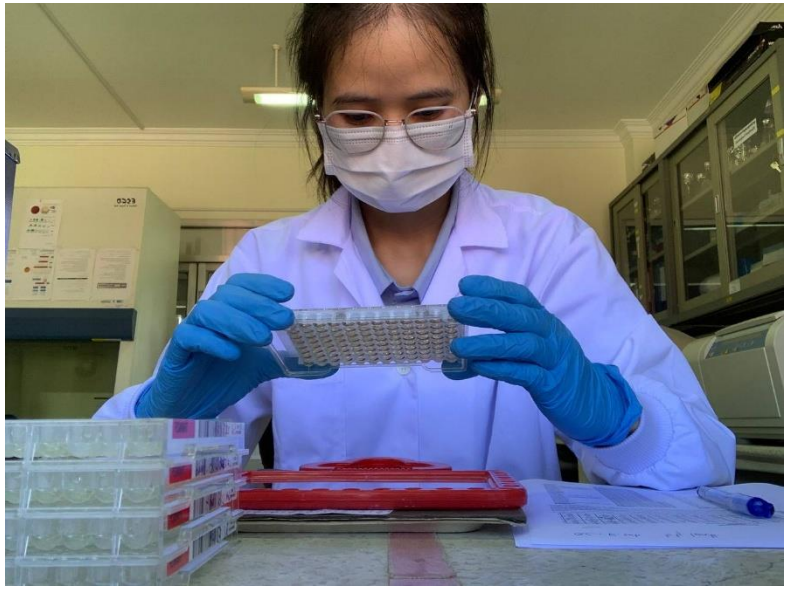


Table x. Summary AST total in all three provinces in *E. coli from both pig and*

Antimicrobial agent	Testing Range (µg/ml)	Susceptible (%)	Intermediate (%)	Resistance (%)
Ceftriaxone (AXO)	0.5 – 32	2 (1.0%)	0	199 (99.0%)
Amikacin (AMI)	8 – 32	27 (13.4%)	174 (86.6%)	0
Ampicillin (AMP)	8 – 16	157 (78.1%)	1 (0.5%)	43 (21.4%)
Ciprofloxacin (CIP)	0.06 – 2	26 (12.9%)	22(10.9%)	153 (76.1%)
Doripenem (DOR)		0	0	201 (100.0%)
Cefepime (FEP)		0	18(9.0%)	183 (91.0%)
Cefotazime (FOT)		0	16(8.0%)	185 (92.0%)
Cefoxitin (FOX)		0	28(13.9%)	173 (86.1%)
Imipenem (IMI)		3(1.5%)	20(10.0%)	178 (88.6%)
Gentamicin (GEN)		115(57.2%)	12(6.0%)	74 (36.8%)
Levofloxacin (LEVO)		19(9.5%)	11(5.5%)	171 (85.1%)
Piperacilin/tazobactam contant4 (P/T4)		1(0.5%)	0	200 (99.5%)
Ertapenem (ETP)		14(7.0%)	18(9.0%)	169 (84.1%)
Meropenem (MERO)		0	0	201 (100.0%)
Cefuroxime (FUR)		6(3.0%)	15(7.5%)	180 (89.6%)
Trimethoprim/sulfamethoxazole (SXT)		140(69.7%)	0	61 (30.3%)
Ceftazidime (TAZ)		7(3.5%)	2(1.0%)	192(95.5%)
Netilmicin (NET)		2(1.0%)	93(46.3%)	106(52.7%)
Colistin (COL)		29(14.4%)	0	172(85.6%)
Ampicillin/sulbactam 2:I ratio (A/S2)		36(17.9%)	60(29.9%)	105(52.2%)
Amoxicillin / clavulanic acid 2:I ratio (AUG2)		0	101(50.2%)	100(49.8%)

Table 10. Antimicrobial Susceptibility profile of *E. coli* in chicken and pig farm in three provinces.

Antimicrobial agent	Resistance profile of E.coli isolated from pig and chicken farms		
	Number (%) resistance profile in both chicken and pig farm (n=201)	Number (%) resistance profile in Chicken farm (n=111)	Number (%) resistance profile in Pig farm (n=90)
Ceftriaxone (AXO)	2 (1.0%)	2 (1.8%)	0
Amikacin (AMI)	28 (13.9%)	8 (7.2%)	20 (22.2%)
Ampicillin (AMP)	160 (79.6%)	82 (73.9%)	78 (86.7%)
Ciprofloxacin (CIP)	26 (12.9%)	14 (12.6%)	12 (13.3%)
Doripenem (DOR)	0	0	0
Cefepime (FEP)	0	0	0
Cefotazime (FOT)	0	0	0
Cefoxitin (FOX)	0	0	0
Imipenem (IMI)	3 (1.5%)	1 (0.9%)	2 (2.2%)
Gentamicin (GEN)	112 (55.7%)	52 (46.8%)	60 (66.7%)
Levofloxacin (LEVO)	19 (9.5%)	9 (8.1%)	10 (11.1%)
Piperacilin/tazobactam contant4 (P/T4)	1 (0.5%)	1 (0.9%)	0
Ertapenem (ETP)	14 (7.0%)	8 (7.2%)	6 (6.7%)
Meropenem (MERO)	0	0	0
Cefuroxime (FUR)	6 (3.0%)	2 (1.8%)	4 (4.4%)
Trim/ethoprim/sulfamethoxazole (SXT)	139 (69.2%)	67 (60.4%)	72 (80.0%)
Ceftazidime (TAZ)	8 (4.0%)	3 (2.7%)	5 (5.6%)
Netilmicin (NET)	2 (1.0%)	2 (1.8%)	0
Colistin (COL)	28 (13.9%)	19 (17.1%)	9 (10.0%)
Ampicillin/sulbactam 2:1 ratio (A/S2)	36 (17.9%)	35 (31.5%)	1 (1.1%)
Amoxicillin / clavulanic acid 2:1 ratio (AUG2)	0	0	0

Table 11. Resistance Profile of *Salmonella* isolated from Pig and Chicken Farm in the three provinces in Cambodia

Antimicrobial agent	N resistance (%) in Chicken and Pig farm (n=50)	N Resistance (%) in Chicken farm (n-24)	N Resistance (%) in in pig farm (n=26)
Ceftriaxone (AXO)	50 (100%)	24 (100%)	26 (100%)
Amikacine (AMI)	13 (26%)	7 (29%)	6 (23%)
Ampicillin (AMP)	31 (62%)	16 (67%)	15 (58%)
Ciprofloxacin (CIP)	10 (20.2%)	4 (67%)	6 (23%)
Doripenem (DOR)	0	0	0
Cefepime (FEP)	50 (100%)	24 (100%)	26 (100%)
Cefotazime (FOT)	50 (100%)	24 (100%)	25 (96%)
Cefoxitin (FOX)	0	0	0
Imipenem (IMI)	0	0	0
Gentamicin (GEN)	6 (12%)	3 (13%)	3 (12%)
Levofloxacin (LEVO)	11 (22.1%)	8(33%)	3 (12%)
Piperacilin/tazobactam contant4 (P/T4)	0	0	0
Ertapenem (ETP)	8 (16%)	5 (21%)	3 (12%)
Meropenem (MERO)	0	0	0
Cefuroxime (FUR)	43 (86%)	24 (100%)	19 (73%)
Trim/ethoprim/sulfamethoxazole (SXT)	8 (16%)	5 (21%)	3 (12%)
Ceftazidime (TAZ)	6 (12%)	4 (17%)	2 (8%)
Netilmicin (NET)	0	0	0
Colistin (COL)	40 (80%)	20 (83%)	20 (77%)
Ampicillin/sulbactam 2:I ratio (A/S2)	4 (80%)	0	4 (15%)
Amoxicillin / clavulanic acid 2:I ratio (AUG2)	0	0	0

6. Other study of AMR in animal health

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Antimicrobials in small-scale urban pig farming in a lower middle-income country – arbitrary use and high resistance levels

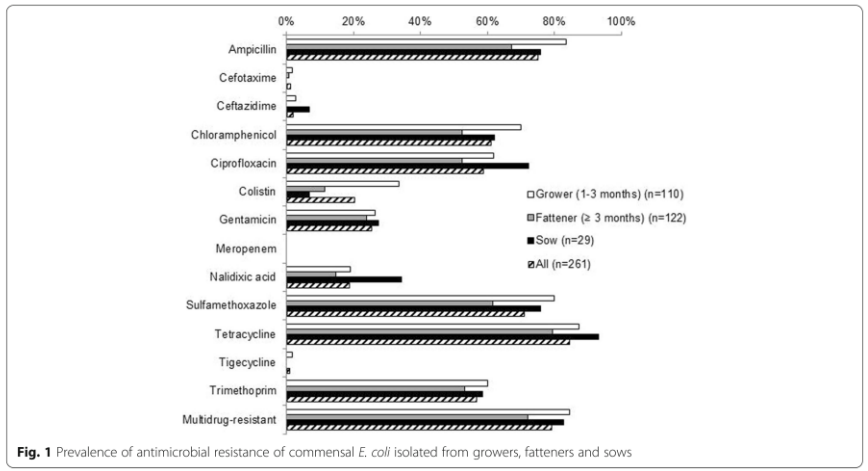

Fig. 1 Prevalence of antimicrobial resistance of commensal *E. coli* isolated from growers, fatteners and sows

Table 7 Resistance and distribution of Minimum Inhibitory Concentrations (MIC) of antimicrobials for *E. coli* from fatteners[a] ($n = 122$)

Antimicrobial	Resistance (%)	Distributions (%) of MICs (mg/L) 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	512	1024	>1024
Ampicillin	67.2								13.1	18.0	1.6			0.8	66.4				
Azithromycin[b]	-								1.6	5.7	36.1	45.9	9.0	0.8	0.8				
Cefotaxime	0.8						99.2			0.8									
Ceftazidime	0.0							100											
Chloramphenicol	52.5										43.4	4.1	9.8	8.2	25.4	9.0			
Ciprofloxacin	52.5	24.6	13.1	9.8	0.8	9.8	24.6	10.7		1.6	0.8	4.1							
Colistin	11.5							81.1	7.4	11.5									
Gentamicin	23.8							8.2	27.0	41.0	11.5			1.6	10.7				
Meropenem	0.0			96.7	3.3														
Nalidixic acid	14.8									41.8	29.5	13.9	6.6		1.6	6.6			
Sulfamethoxazole	61.5										6.6	15.6	14.8	1.6		0.8	0.8		59.8
Tetracycline	79.5								8.2	9.0	3.3		11.5	32.0	36.1				
Tigecycline	0.0						91.8	8.2											
Trimethoprim	53.3						1.6	26.2	17.2	1.6	1.6			51.6					

White fields represent range of dilutions tested for each antimicrobial. MICs higher than the highest concentration tested are given as the concentration closest above the range. MICs equal to or lower than the lowest concentration tested are underlined. The epidemiological cut-off value (ECOFF) [33] for each antimicrobial is presented as a vertical line

[a]Pigs older than 3 months

[b]No ECOFF was available for azithromycin

Ström et al., 2018

ការអនុវត្តឃ្លាំមើលលើភាពស៊ាំនឹងឱសថប្រឆាំងមេរោគ (AMR surveillance) របស់ *E.coli* និង *Salmonella* លើសាច់មាន់នៅតាមទីផ្សារក្នុងរាជធានីភ្នំពេញ

PILOT RESULT OF ANTIMICROBIAL RESISTANCE PROFILES OF *SALMONELLA* SPP. ISOLATED FROM FREE RANGE AND CAGE CHICKEN MEAT IN PHNOM PENH MARKET

តារាងទី ២ ៖ ប្រសិទ្ធភាពនៃឱសថអង់ទីប៉ូទិចទៅលើបាក់តេរី *Salmonella* spp. នៅក្នុងសាច់មាន់

ឈ្មោះឱសថ	មានប្រសិទ្ធភាព	ខិតទៅរកភាពស៊ាំ	មានភាពស៊ាំ
Ceftazidime	១២ (៩២,៣០ %)	០ (0%)	១ (៧,៧០ %)
Gentamycin	៦ (៤៦,១៥ %)	១ (៧,៧០ %)	៦ (៤៦,១៥ %)
Florfenicol	៩ (៦៩,២៣ %)	០ (0%)	៤ (៣០,៧៧ %)
Nalidic acid	១ (៧,៦៩ %)	៤ (៣០,៧៩ %)	៨ (៦១,៥៣ %)
Tetracycline	២ (១៥,៣៨ %)	២ (១៥,៣៨ %)	៩ (៦៩,២៣ %)
Sulfamethoxazole	៣ (២៣,០៧ %)	០ (0%)	១០ (៧៦,៩២ %)
Cefuroxime	១៣ (១០០ %)	០ (0%)	០ (0%)
Kanamycin	០ (0%)	៣ (២៣,០៧ %)	១០ (៧៦,៩២ %)
Cephazolin	១៣ (១០០%)	០ (0%)	០ (0%)
Streptomycin	០ (0%)	០ (0%)	១៣ (១០០%)
Ampicillin	៩ (៦៩,២៣ %)	០ (0%)	៤ (៣០,៧៦ %)
Ciprofloxacin	៦ (៤៦,១៥ %)	០ (0%)	៧ (៥៣,៨៤ %)
Chloramphenicol	៣ (២៣,០៧ %)	៤ (៣០,៧៦ %)	៦ (៤៦,១៥ %)
Erythromycin	០ (0%)	០ (0%)	១៣ (១០០%)

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