Antimicrobial stewardship in Indonesia aquaculture practices

“Veterinarians & one health approaches”

Huda S Darusman*, Siti Fatimah**, Syifa Afianti**, Mario V Siahaan**

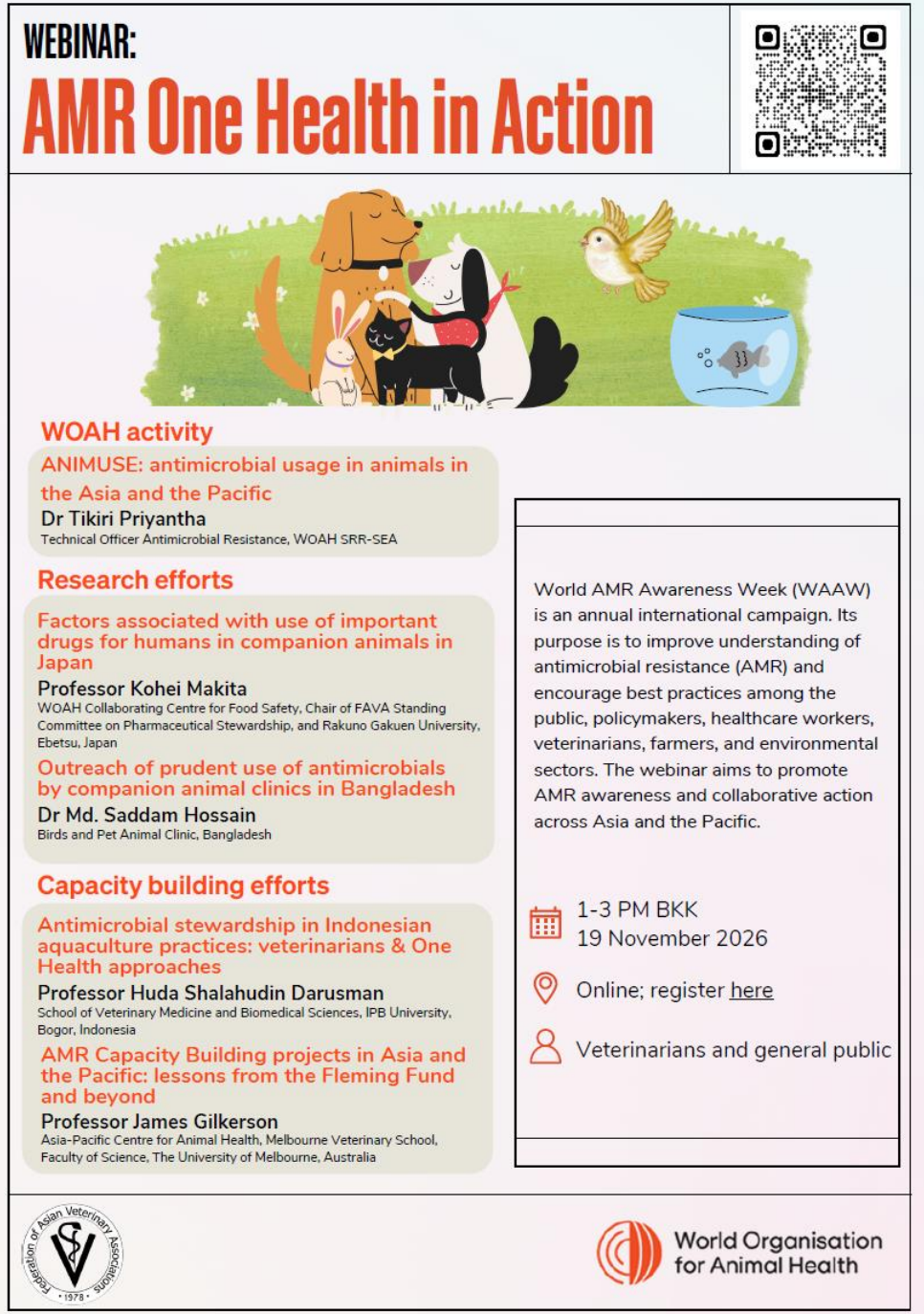
(* School of Veterinary Medicine and Biomedical Sciences

(** Ministry of Marine Affairs and Fisheries



Contents of presentation:

- **Trends in AMU & complications**
- **Antimicrobial stewardship: one health approaches & veterinarian roles**
- How we (Indonesian) do our best to comply the antimicrobial stewardship



scientific reports

Check for updates

OPEN

Global trends in antimicrobial use in aquaculture

Daniel Schar[1,2], Eili Y. Klein[2], Ramanan Laxminarayan[2,3], Marius Gilbert[1,4,6] & Thomas P. Van Boeckel[2,5,6]

www.nature.com/scientificreports/



Figure 1. Antimicrobial consumption in aquaculture in 2017 and 2030 (projected, Supplementary material).

Trends by antimicrobial class. Globally, the most commonly used classes of antimicrobials were, by frequency of use, quinolones (27%), tetracyclines (20%), amphenicols (18%), and sulfonamides (14%). Antimicrobials listed by the World Health Organization (WHO) as critically important and highly important for human medicine[39] accounted for 35% and 61% of use, respectively, across surveys (Supplementary Fig. S4). Mean use coefficients were highest for first generation cephalosporins at 85 mg kg^{-1}, lincosamides at 33 mg kg^{-1}, and tetracyclines at 23 mg kg^{-1} (95% UI 11–45), although uncertainty intervals could not be generated for the former two classes due to limited sample sizes.

www.nature.com/scientificreports/

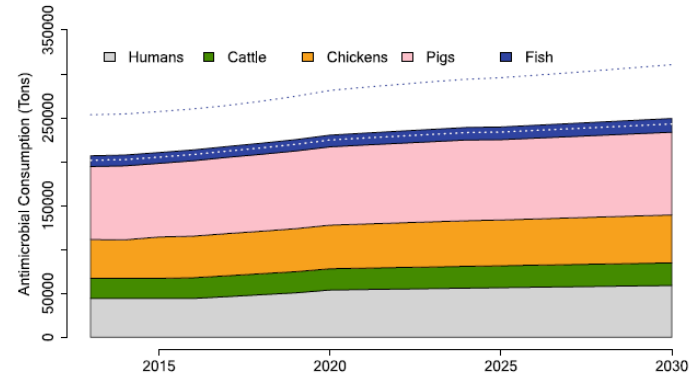


Figure 3. Global antimicrobial consumption, 2013–2030. Dotted lines represent the 95% uncertainty interval for fish.

www.nature.com/scientificreports/

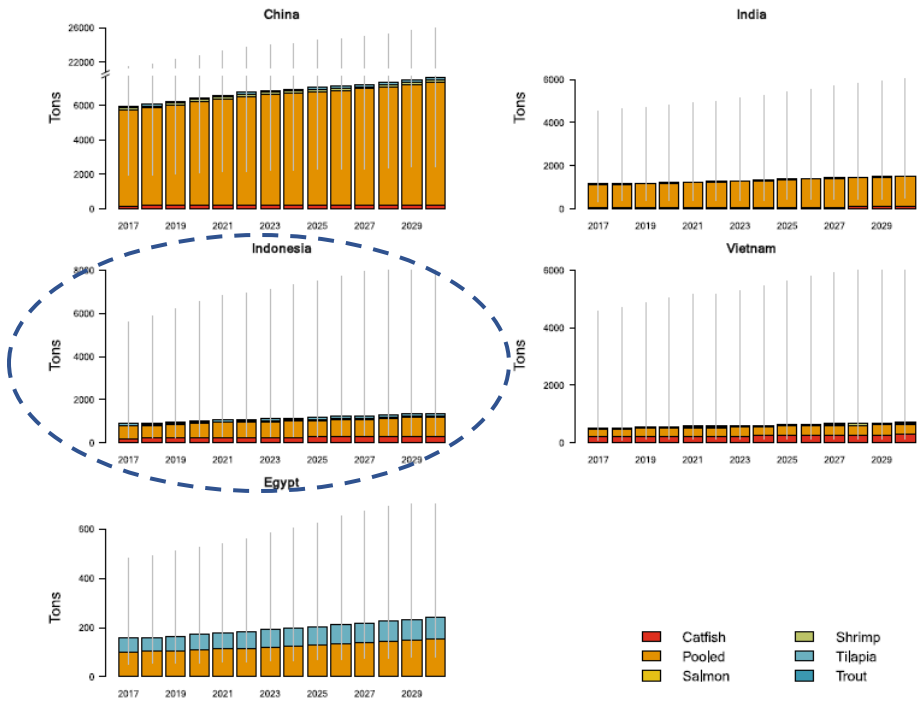


Figure 2. Projected antimicrobial use (tons) in aquaculture by species by 2030 in the five highest-consuming countries. The China panel y-axis is broken at 8000 and resumes at 20,000 tons. Error bars represent the 95% uncertainty intervals for the annual total use.

Global trends Antimicrobial Use (AMU)

www.nature.com/scientificreports/

- Studies in China, Egypt, India, Indonesia & Vietnam
- In Indonesia, AMU are use for aquaculture of catfish, tilapia & pooled
  - Shrimps is **excluded**
- Most AMU:
  - 27% Quinolon (Enrofloxacin)
  - 20% Tetrasiklin (Oksitetracycline)
  - 18% phenicol ➔ **not in Indonesia**
  - 14% Sulfonamida

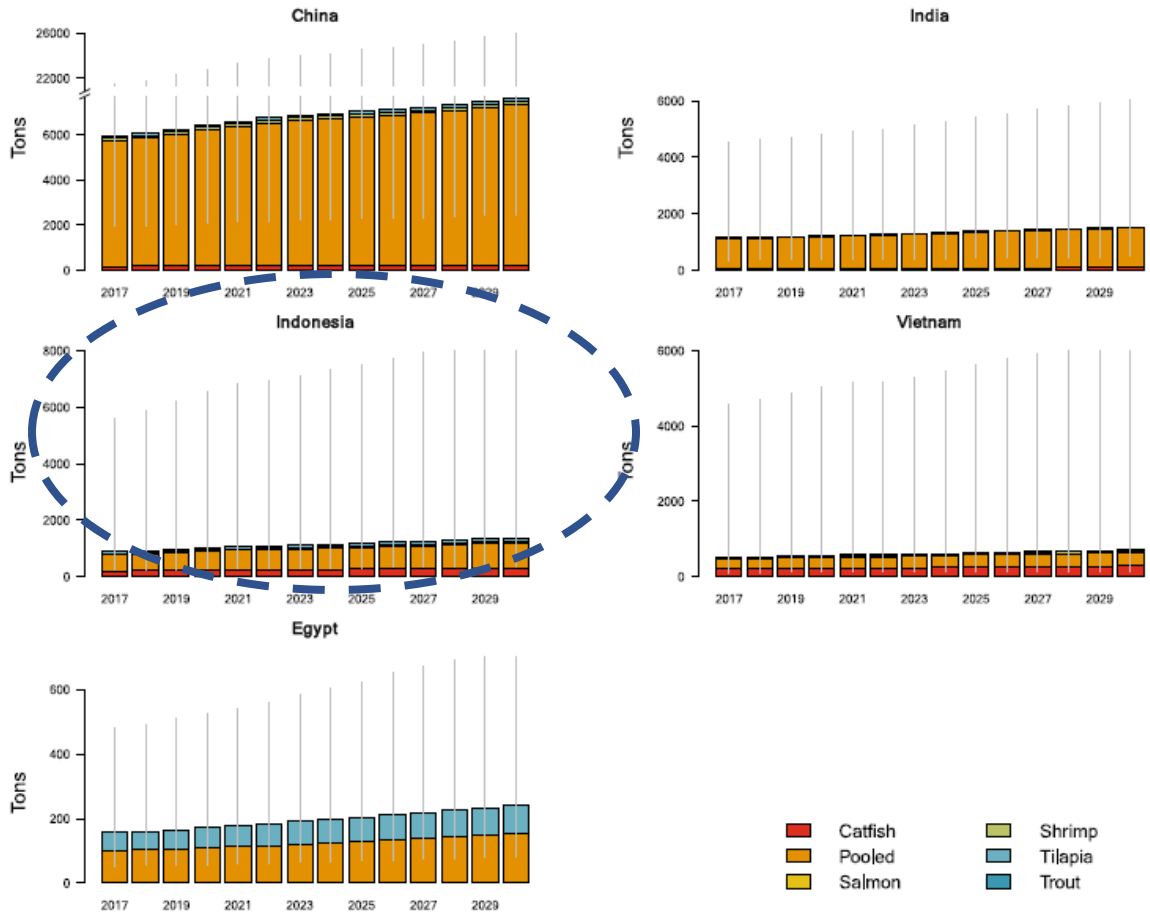


Figure 2. Projected antimicrobial use (tons) in aquaculture by species by 2030 in the five highest-consuming countries. The China panel y-axis is broken at 8000 and resumes at 20,000 tons. Error bars represent the 95% uncertainty intervals for the annual total use.

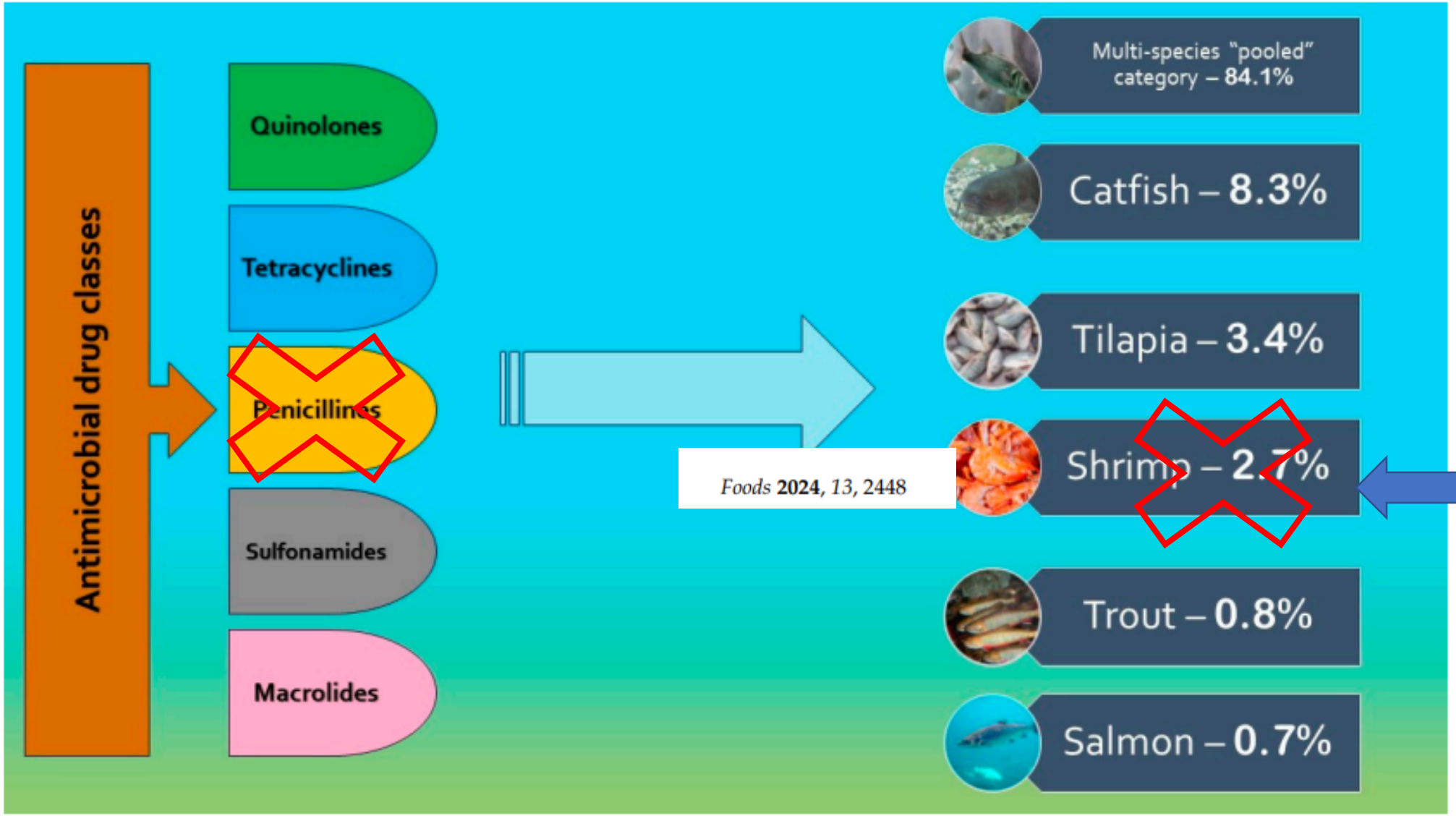


Figure 1. List of antimicrobial drug classes most commonly used in aquaculture and AMU trends (%) by species (adapted from Schar et al. [40]).

Antimicrobial use & complications

- Use in prevention/prophylactic usages
- Extra-label drugs
  - Low dosages (overuse)
  - High dosages (underuse)
- Low sanitations
  - Biosafety & biosecurity issues
- Compliances to withdrawal time → residue & AMR
- Resistance microbes:
  - Aeromonas hydrophila & E.coli

WARTA IKTIOLOGI
Vol 5(3) Desember 2021: 57-62

PENGGUNAAN ANTIBIOTIKA DI AKUAKULTUR DENGAN BIJAK UNTUK PENGENDALIAN RESISTANSI ANTI MIKROBA

[Wise Use of Antibiotics in Aquaculture for The Control of Anti-Microbial Resistance]

Angela Mariana Lusiastuti

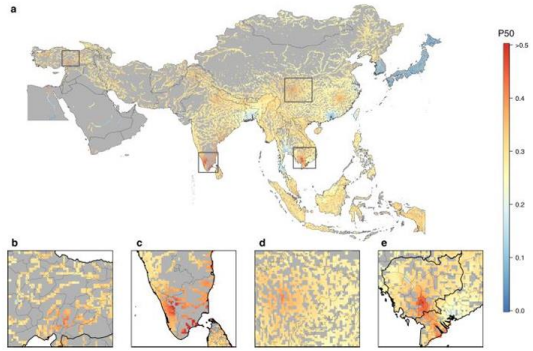
Balai Riset Perikanan Budidaya Air Tawar & Penyuluhan Perikanan
Jl. Sempur No. 1 Bogor, Jawa Barat 16129

Warta Iktiologi
Diterbitkan
Masyarakat Iktiologi Indonesia
ISSN: 2579-8626

1. Pendahuluan

Akuakultur menyediakan 20% protein hewani untuk pangan dari 40% protein yang diperlukan dunia, sehingga, hal ini menyebabkan produksi ikan dunia mengalami pertumbuhan yang pesat. Dari tahun 1960 hingga 2018, produksi hewan akuatik untuk konsumsi dunia meningkat dari 21,8 menjadi 156,4 juta ton (FAO 2020; Fisheries and Aquaculture 2016). Asia penyumbang produksi terbesar yaitu 69% pada tahun 2018, dengan China mewakili 35% produksi global. Pertumbuhan yang cepat dalam produksi protein hewani ini diikuti oleh transisi dari akuakultur ekstensif ke intensif, yang secara historis disertai dengan peningkatan penggunaan antimikroba untuk pengendalian penyakitnya (Van Boeckel *et al.*, 2015, 2017). Dalam akuakultur, beberapa spesies ikan, sebagai contoh seperti ikan lele, dikaitkan dengan tingkat penggunaan antimikroba per kilogram yang melebihi hewan darat dan manusia (Schar *et al.* 2020).

Antimicrobial resistance (AMR) atau resistansi antimikroba menjadi *trending topic* di dunia karena



Gambar 1. Survei proporsi penggunaan antimikroba resistan yang tinggi lebih dari 50% pada skala kontinental (P50) (a); Turki (b); India (c); Sungai Yangtze di China (d); dan Delta Sungai Mekong (e) (Schar *et al.* 2021).

Antimicrobial Resistance (AMR) from (aquacultures microbes)

- AMR is a phenomenon for bacterial survival

- Mechanism (Blair et al., 2015):
  - Inactivation of the drug
  - Prevention of drug access to targets in bacterial cells
  - Modification of drug targets:
    - Bypass targets: MRSA

- **“Misdiagnosis & maltherapy”**

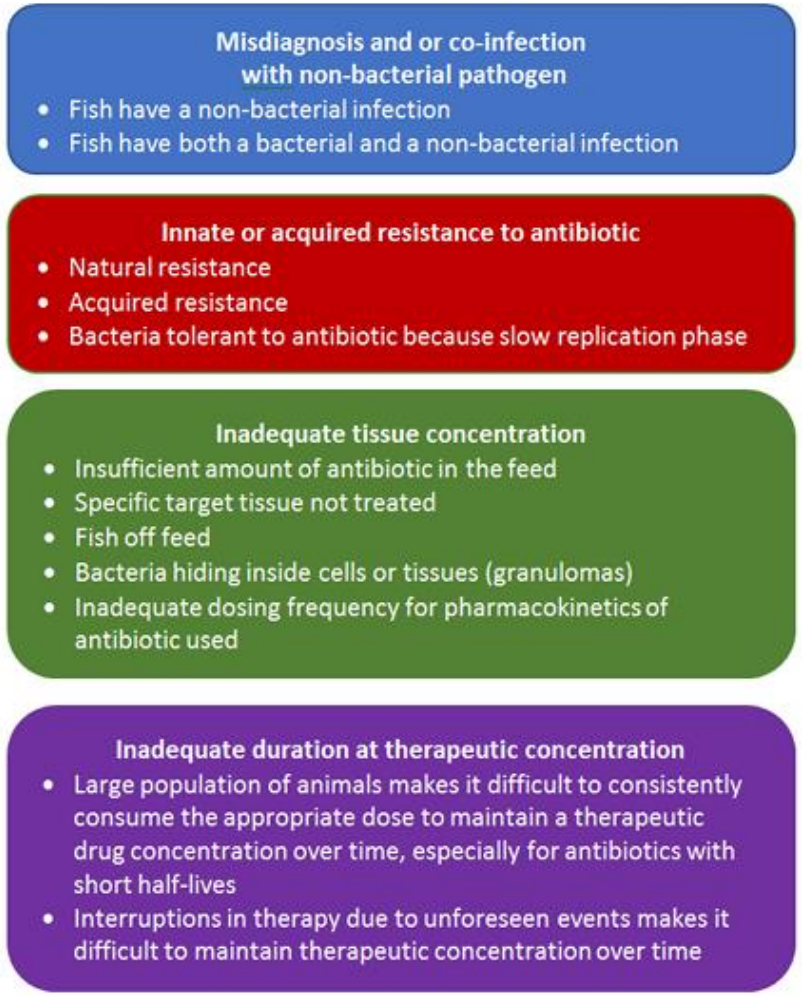


Fig. 2. Specific scenarios that could result in conditions leading to treatment failure.

AMR solutions:

- "Antimicrobial stewardship: Prudent use of antimicrobials therapy
- Residue monitoring
  - Manufacturing level: high-quality of drugs (registered & tested, efficacy and safety)
    - Good Practice in Drug's Production (CPOIB) & withdrawal time (WT)
  - Consumer level: public awareness to AMU (precision in indication, doses & WT)
  - Government: capacity building for MRLs & minimum laboratory requirement for testing: best practic, feasible & multisektor
    - Collaboration of triple helix sector: Academician, Business, Government
- Providing alternatives to AMU:
- **Openness to advances in technologies - Antibiotic resistance breakers (ARBs)**

Contents of presentation:

- Trends in AMU & complications
- **Antimicrobial stewardship: one health approaches & veterinarian roles**
- How we (Indonesian) do our best to comply the antimicrobial stewardship



Antimicrobial stewardship (AMS)

- AMS in aquaculture is a coordinated approach to using veterinary medicines responsibly to:
  - Protect fish health
  - Stopping the spread of antimicrobial resistance (AMR) with **ONE-Health Perspectives**

    ➔across aquatic environments, food chains, and human populations



One health

- A **collaborative, multisectoral, and transdisciplinary** approach—working at the local, regional, national, and global levels—with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment

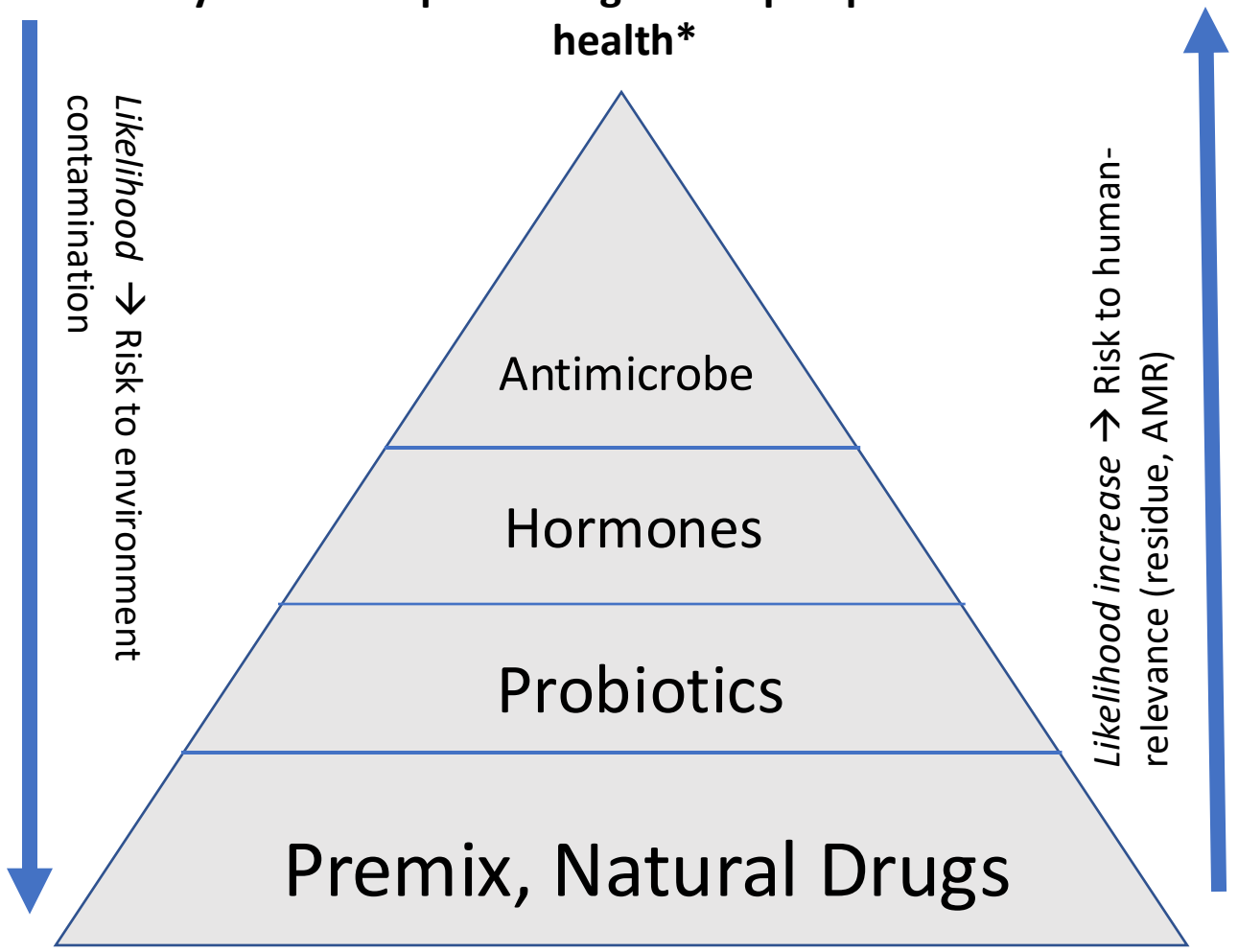
CDC Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

- AMS main pillars
  - Prudent use of antimicrobial
  - **Veterinary oversight**
  - Alternatives to antimicrobe

Aquatic drugs & one-health

- Biologic: Vaccine, Diagnostic Kit
- Pharmaceutical drugs:
  - **Antimicrobe/antibiotic**, hormones, Colouring agents
- Premix:
  - Feed additives
  - Feed supplements
- Probiotic
  - Non pathogenic microbes
  - Bioremediation
- Natural drugs

Pyramid of aquatic drugs risk – perspectives one health*



(*Concept by Darusman et al 2025- unpublished data

Veterinarian oversight of Aquaculture AMS in Indonedia

- Mandatory position as registration officer for drugs' application
- Expertise board of drugs registration at ministerial level
  - Scientific justification to approve the aquaculture drugs registration
- Chair the National Board of Aquatic Drugs Quality Assessment (Aquatic FDA)
- Key persons in residue and AMR monitoring
- Mandatory for prescribing antimicrobial drugs

KEMENTERIAN KELAUTAN DAN PERIKANAN

INSTITUT PERTANIAN BOGOR

IPB University
Bogor Indonesia

Contents of presentation:

- Trends in AMU & complications
- Antimicrobial stewardship: one health approaches & veterinarian roles
- **How we (Indonesian) do our best to comply the antimicrobial stewardship**



Antimicrobial stewardships in Indonesian Aquaculture are tied to:

- **Antimicrobial drugs & the prudent use of antimicrobe**
  - **Restricted AMU (choices & species)**
  - **Therapeutic use only – not prophylactic purposes**
  - **Indicated to infection**
  - **Prescribed by veterinarian**
- Antimicrobial resistance – risk analysis & mitigations
  - Residue monitoring & empowerment of MRLs' lab examination
    - National action plan
  - Capacity building
- Alternatives to antimicrobial drugs

Antimicrobial drugs in Indonesian Aquaculture

- **Under Ministerial Regulations**
- **Antimicrobes are limited to:**
  - **4 groups of antibiotics**
- Non-antimicrobial
  - Anthelmintik
  - Coloring agents/medication dyes
  - Hormone
  - Disinfectant, antiseptic

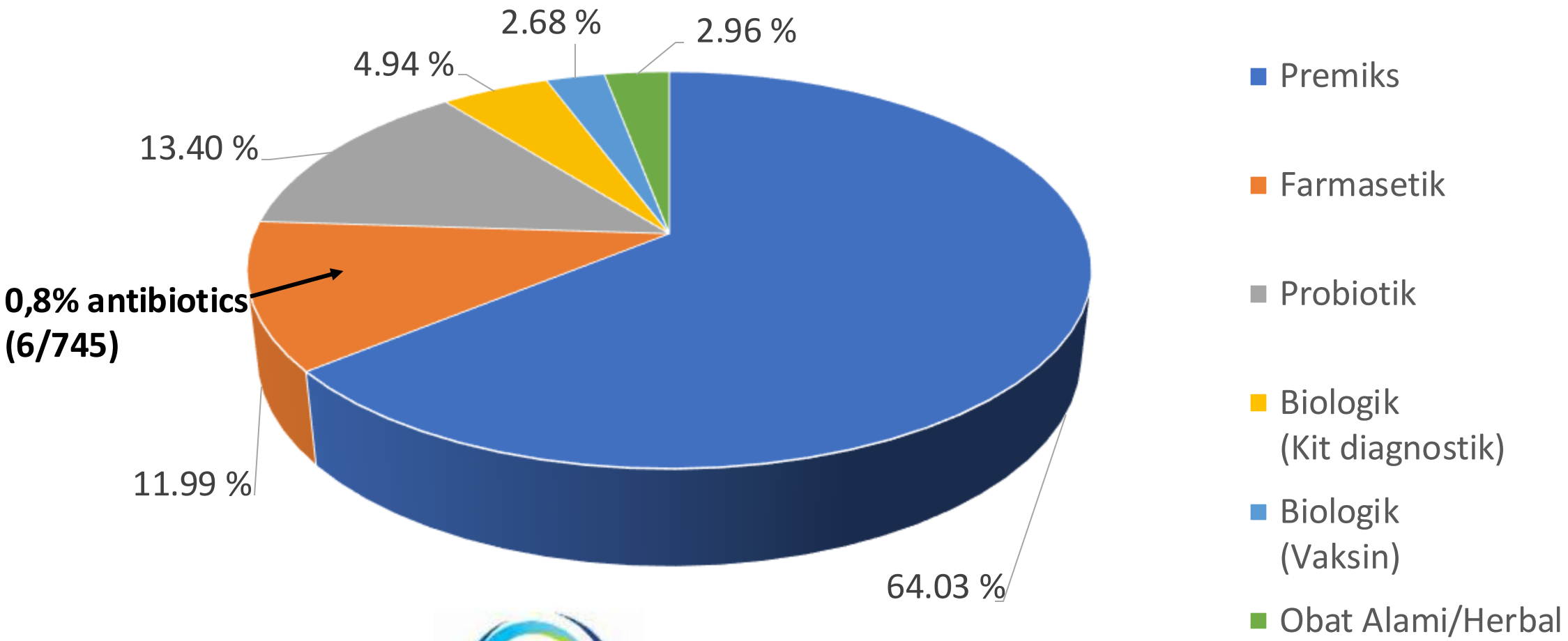
PERATURAN MENTERI KELAUTAN DAN PERIKANAN REPUBLIK INDONESIA
NOMOR 19 TAHUN 2024
TENTANG
OBAT IKAN

(2) Penyediaan Obat Ikan sebagaimana dimaksud dalam Pasal 12 untuk jenis sediaan farmasetik harus memenuhi ketentuan:
a. untuk pengobatan penyakit Ikan tertentu;
b. tidak digunakan untuk pencegahan penyakit Ikan atau sebagai Imbuhan Pakan;
c. tidak digunakan sebagai pemacu pertumbuhan Ikan; dan
d. dapat digunakan sebagai disinfektan dan antiseptik.

a) Antimikroba

No.	Golongan	Nama Zat Aktif
1.	Tetrasiklina	a. *Klortetrasiklina*
		b. *Oksitetrasiklina*
		c. *Tetrasiklina*
2.	Makrolida	*Eritromisina*
3.	Fluorokuinolon	*Enrofloksasina*
4.	Sulfonamid	*Sulfadiazin*

Registered aquaculture drugs up to end 2023 (%)



KEMENTERIAN KELAUTAN DAN PERIKANAN

INSTITUT PERTANIAN BOGOR

IPB University
Bogor Indonesia

Antimicrobial stewardships in Indonesian Aquaculture are tied to:

- Antimicrobial drugs & the prudent use of antimicrobe
  - Restricted AMU (choices & species)
  - Therapeutic use only – not prophylactic purposes
  - Indicated to infection
  - Prescribed by veterinarian
- **Antimicrobial resistance – risk analysis & mitigations**
  - **Residue monitoring & empowerment of MRLs' lab examination**
    - **National action plan**
  - **Capacity building**
- **Alternatives to antimicrobial drugs**

Residue in Indonesian aquaculture practices

- Regulated under miniterial level
  - Permen KP No. 37/2019
  - Kepmen KP No. 26/2025

- Residue survelance (every 3 months)
  - Monitoring of residue
  - Investigation
  - Corrective actions



PERATURAN
MENTERI KELAUTAN DAN PERIKANAN REPUBLIK INDONESIA
NOMOR 37/PERMEN-KP/2019
TENTANG
PENGENDALIAN RESIDU PADA KEGIATAN
PEMBUDIDAYAAN IKAN KONSUMSI



KEPUTUSAN MENTERI KELAUTAN DAN PERIKANAN REPUBLIK INDONESIA
NOMOR 26 TAHUN 2025
TENTANG
NILAI AMBANG BATAS RESIDU PADA IKAN KONSUMSI
HASIL PEMBUDIDAYAAN

DENGAN RAHMAT TUHAN YANG MAHA ESA

MENTERI KELAUTAN DAN PERIKANAN REPUBLIK INDONESIA,

MRLs'& Minimum Laboratory Requirements

NILAI AMBANG BATAS RESIDU PADA IKAN KONSUMSI
HASIL PEMBUDIDAYAAN

KELOMPOK	SUBSTANSI UJI	PARAMETER	KOMODITAS	SATUAN	BMR	BMKL
A (Golongan zat aktif farmakologi yang dilarang)	A1C (Hormon)	Metiltestosteron	Ikan	µg/kg	-	1
	A2 (Antimikroba)	Kloramfenikol	Ikan dan Udang	µg/kg	-	0,15
		Metabolit Nitrofuran (AOZ, AMOZ, SEM, AHD)	Ikan dan Udang	µg/kg	-	0,5
		Dimetridazol	Ikan dan Udang	µg/kg	-	1
	A3a (Pewarna)	Malachite green dan Leucomalachite green	Ikan dan Udang	µg/kg	-	0,5
		Crystal violet dan Leucocrystal violet	Ikan dan Udang	µg/kg	-	0,5
B (Golongan zat aktif farmakologi yang diperbolehkan)	B1a (Antimikroba)	Tetrasiklin	Ikan dan Udang	µg/kg	100	-
		Oksitetrasiklin	Ikan dan Udang	µg/kg	100	-
		Klortetrasiklin	Ikan dan Udang	µg/kg	100	-
		Sulfonamida	Ikan dan Udang	µg/kg	100	-
		Enrofloksasin	Ikan dan Udang	µg/kg	100	-
		Eritromisin	Ikan	µg/kg	200	-
	B1b (Antelmintik)	Emamectin	Ikan dan Udang	µg/kg	100	-
C (Pestisida)	C (Organoklorin)	Hexachlorobenzene	Ikan dan Udang	µg/kg	10	-
		Aldrin dan Dieldrin	Ikan dan Udang	µg/kg	10	-
		Chlordane	Ikan dan Udang	µg/kg	10	-
		Heptachlor dan Heptachlor Epoxida	Ikan dan Udang	µg/kg	10	-
		Lindane	Ikan dan Udang	µg/kg	10	-
		Endrin	Ikan dan Udang	µg/kg	10	-
		DDT	Ikan dan Udang	µg/kg	10	-
D (Kontaminan)	D1 (Polutan organik yang persisten)	PCB	Ikan dan Udang	ng/g	75	-
	D2 (Logam berat)	Merkuri (Hg)	Ikan dan Udang	mg/kg	0,5	-
		Timbal (Pb)	Ikan	mg/kg	0,3	-
			Udang	mg/kg	0,5	-
		Kadmium (Cd)	Ikan	mg/kg	0,05	-
			Udang	mg/kg	0,5	-

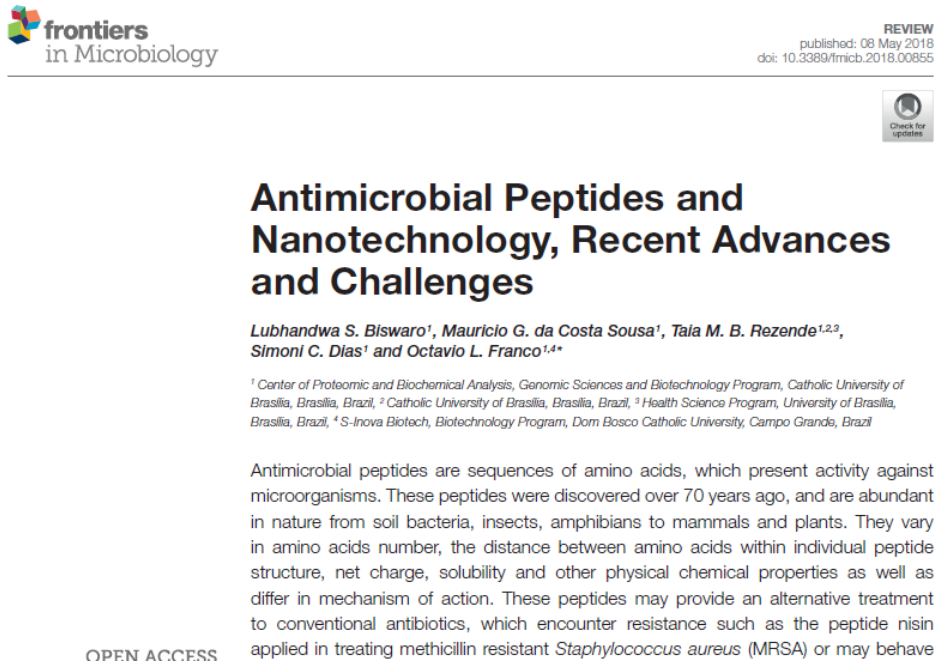
MENTERI KELAUTAN DAN PERIKANAN
REPUBLIK INDONESIA,

Ditandatangani
Secara Elektronik

SAKTI WAHYU TRENGGONO

Alternatives to antimicrobes: provided & undergoes research in Indonesia

- Major pharmaceuticals
  - Probiotic
  - Organic acids & enzymes
  - Minerals & supplements
  - Antiseptic & desinfectant
    - Bioremediation hatcheries & media
- Imunotherapies/imunomodulator
- Good Veterinary Practices
- Implementation of **Biosecurity**
- Vaccinations
- **Biotech:**
  - **Antimikrob peptida (AMP), RNA-based antimicrobe**
  - **Bacteriophages**
- Bahan alam ☺



frontiers in Microbiology

REVIEW
published: 08 May 2018
doi: 10.3389/fmicb.2018.00855

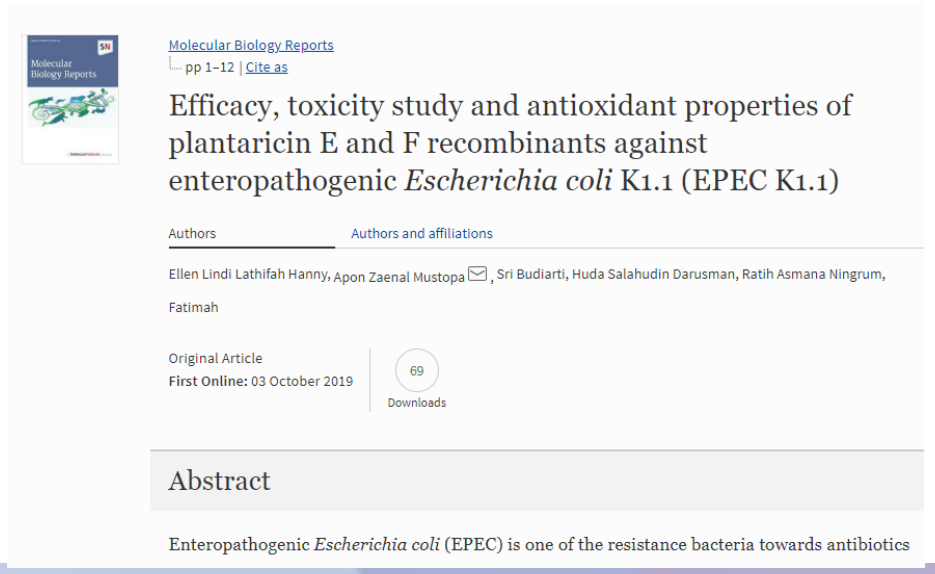
Antimicrobial Peptides and Nanotechnology, Recent Advances and Challenges

Lubhandwa S. Biswaro[1], Mauricio G. da Costa Sousa[1], Taia M. B. Rezende[1,2,3], Simoni C. Dias[1] and Octavio L. Franco[1,4]*

[1] Center of Proteomic and Biochemical Analysis, Genomic Sciences and Biotechnology Program, Catholic University of Brasília, Brasília, Brazil, [2] Catholic University of Brasília, Brasília, Brazil, [3] Health Science Program, University of Brasília, Brasília, Brazil, [4] S-Inova Biotech, Biotechnology Program, Dom Bosco Catholic University, Campo Grande, Brazil

Antimicrobial peptides are sequences of amino acids, which present activity against microorganisms. These peptides were discovered over 70 years ago, and are abundant in nature from soil bacteria, insects, amphibians to mammals and plants. They vary in amino acids number, the distance between amino acids within individual peptide structure, net charge, solubility and other physical chemical properties as well as differ in mechanism of action. These peptides may provide an alternative treatment to conventional antibiotics, which encounter resistance such as the peptide nisin applied in treating methicillin resistant *Staphylococcus aureus* (MRSA) or may behave

OPEN ACCESS



Molecular Biology Reports
pp 1–12 | Cite as

Efficacy, toxicity study and antioxidant properties of plantaricin E and F recombinants against enteropathogenic *Escherichia coli* K1.1 (EPEC K1.1)

Authors | Authors and affiliations

Ellen Lindi Lathifah Hanny, Apon Zaenal Mustopa, Sri Budiarti, Huda Salahudin Darusman, Ratih Asmana Ningrum, Fatimah

Original Article
First Online: 03 October 2019

69 Downloads

Abstract

Enteropathogenic *Escherichia coli* (EPEC) is one of the resistance bacteria towards antibiotics

AMS in Indonesian Aquaculture Practices

Regulation

Regulation:

Drug registration

GMP of aquaculture drugs

AMU & monitoring procedure

Practices

One-Health & Vets' roles:

Prescription & therapy-use only

AMR & residue monitoring

Public awareness

Antimicrobial Stewardships

1. Prudent use of antimicrobe
2. Reduced risk to AMR
3. Alternatives to antimicrobe



Thank you

FAVA & WOAH

Webinar Organizer

Ministry of Marine Affair & Fisheries

School of Vet Med & Biomed Sci, IPB

Kind participants today ☺

