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**ISOLATION, PREVALENCE AND ANTIBIOTIC
RESISTANCE OF *Salmonella* spp. IN FISH OBTAINED
FROM WET MARKETS IN PENANG,
MALAYSIA**

by

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A dissertation submitted in partial fulfilment of the requirement for the degree of
Bachelor of Technology (B. Tech) in the field of Food Technology
School of Industrial Technology
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DECLARATION BY AUTHORS

This dissertation is composed of my original work and contains no material previously published or written by another person except where due reference has been made in the text. The content of my dissertation is the result of work I have carried out since the commencement of my research project and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution.

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LIST OF ABBREVIATIONS

Abbreviations	Definition
°C	Degree celsius
%	Percent
AMR	Antimicrobial resistance
AST	Antimicrobial susceptibility test
BAM	Bacteriological Analytical Manual
BPW	Buffered Peptone Water
CDC	Centers for Disease Control and Prevention
CFU	Colony forming unit
CLSI	Clinical and Laboratory Standards Institute
DVS	Department of Veterinary Services
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
EUCAST	European Committee on Antimicrobial Susceptibility Testing
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration
g	Gram
HEA	Hektoen Enteric Agar
ISO	International Organization for Standardization
Kb	kilo base
LIA	Lysine Iron Agar
LPS	Lipopolysaccharides
mL	Millilitre
MAR	Multiple antimicrobial resistance

MDR	Multidrug-resistant
MIC	Minimum Inhibitory Concentration
MKTTn	Muller-Kauffmann Tetrathionate-novobiocin broth
MOH	Ministry of Health of Malaysia
MPI	Major Pathogenicity Island
NA	Nutrient Agar
NTS	Non-typhoidal <i>Salmonella</i>
PCR	Polymerase Chain Reaction
RTE	Ready-to-eat
RNA	Ribonucleic acid
RVS	Rappaport Vassiliadis Soy Broth
SPI	<i>Salmonella</i> Pathogenicity Islands
T1SS	Type I Secretion System
T3SS	Type III Secretion System
TSA	Trypticase Soy Agar
TSB	Trypticase Soya Broth
TSI	Triple Sugar Iron
WHO	World Health Organization
XLD	Xylose Lysine Deoxycholate

**PEMENCILAN, KELAZIMAN DAN KERINTANGAN ANTIBIOTIK SPESIS
Salmonella DALAM IKAN YANG DIPEROLEHI DARI PASAR BASAH
DI PENANG, MALAYSIA**

ABSTRAK

Salmonella merupakan patogen bawaan makanan yang boleh menyebabkan jangkitan pada manusia. Umumnya, patogen bawaan makanan ini disebarkan melalui ayam dan produk ayam. Namun, peningkatan peyebaran *Salmonella* melalui ikan amat membimbangkan. Sumber pencemaran ikan amat penting untuk mengesan pathogen bawaan makanan. Tujuan kajian ini adalah untuk menentukan pengasingan, kelaziman dan kerintangan antibiotik *Salmonella* spp. yang dipencilkan dari ikan yang dijual di pasar basah di Pulau Pinang, Malaysia. Pemencilan *Salmonella* spp. dari sampel ikan dilakukan melalui prosedur bakteriologi ISO-6579-1. Kaedah biokimia dan ujian serotaip pengagregatan slaid digunakan untuk pengesahan *Salmonella* spp. Kerintangan antibiotik dijalankan dengan kaedah penyebaran cakera Kirby-Bauer mengikut garis panduan “Clinical and Laboratory Standards Institute (CLSI)”. Sebanyak 30 sampel ikan (ikan air tawar dan air laut) dipilih secara rawak dari 3 pasar basah di Pulau Pinang, Malaysia. Sebanyak 13 (43.3%) sampel ikan adalah positif untuk *Salmonella* spp. Ikan air tawar (66.7%) mempunyai kadar pencemaran yang lebih tinggi daripada ikan air laut (27.8%). Semua isolat *Salmonella* mempunyai kerintangan antibiotik terhadap sekurang-kurangnya empat antibiotik. Isolat tersebut menunjukkan rintangan antibiotik yang tinggi (100%) terhadap ampisilin, asid “amoxicillin-clavulanic”, tetrasiklin dan kanamisin. Isolat CY01, CY02 dan SZ02 menunjukkan nilai indeks ketahanan antibiotik berganda (MAR) yang tinggi iaitu sebanyak 0.86 dan menunjukkan ketahanan terhadap enam antibiotik. Peningkatan tahap kerintangan antimikrob (AMR) *Salmonella* dari ikan berpotensi menimbulkan masalah kesihatan awam. Kesukaran dalam membendung kerintangan antibiotik

berkemungkinan membawa pelbagai kemudatan terhadap kesihatan dan kesejahteraan manusia dan haiwan. Langkah pencegahan seperti amalan kebersihan yang betul dan pengendalian ikan yang lebih baik di pasar basah amat penting untuk mencegah penyakit salmonellosis.

**ISOLATION, PREVALENCE AND ANTIBIOTIC RESISTANCE OF
Salmonella spp. IN FISH OBTAINED FROM WET MARKETS
IN PENANG, MALAYSIA**

ABSTRACT

Salmonella is the foodborne pathogen that can cause infection to human. The main reservoir of *Salmonella* is usually associated with poultry and poultry products. Fish can be the source of human infection if the fish product are contaminated through the aquatic environment and post-harvest handling. However, insufficient information is reported on the occurrence of *Salmonella* from fish in Malaysia. The aim of this study was to isolate *Salmonella* spp. from fish sold at wet markets in Penang, Malaysia and determine its antimicrobial susceptibility profiles. Isolation of *Salmonella* spp. from fish samples was performed using ISO-6579-1 bacteriological procedures. The isolates were confirmed through biochemical test and serotyped by slide agglutination test. Susceptibility of the isolates to 8 antimicrobials was conducted using Kirby-Bauer disk diffusion method according to the guidelines of the Clinical and Laboratory Standards Institute (CLSI). A total of 30 fish samples (freshwater and seawater fish) were selected randomly from 3 wet markets in Penang, Malaysia. A total of 13 (43.3%) fish samples were positive for *Salmonella*. Freshwater fish (66.7%) has a higher contamination rate than seawater fish (27.8%). All *Salmonella* isolates investigated were resistant to at least four antibiotics. High resistance rate (100%) was recorded to ampicillin, amoxicillin-clavulanic acid, tetracycline and kanamycin. Isolate CY01, CY02 and SZ02 exhibited the highest multiple antibiotic resistance (MAR) index value of 0.86 which showed resistance to six antibiotics. Emergence of such multidrug resistant strains of *Salmonella* from fish is a potential serious threat to global public health. Difficulties in controlling the rise of antibiotic resistance are likely to cause adverse side effects to both human beings and animals. Preventive measures such as