



Editor-in-Chief

Anjum V. Sherasiya - Ex-Veterinary Officer, Department of Animal Husbandry, Gujarat State, India
<https://orcid.org/0000-0002-1598-1820>

Founding Associate Editor

R. G. Jani - Ex-Coordinator of Wildlife Health, Western Region Centre, Indo-US Project, Department of Veterinary Medicine, Veterinary College, Anand Agricultural University, Anand - 388001, Gujarat, India.

Associate Editors

B. A. Lubisi - Virology, MED Programme, ARC - Onderstepoort Veterinary Institute, No. 100 Old Soutpan Road, Onderstepoort, Tshwane, 0110, South Africa
Google Scholar profile: <https://scholar.google.com/citations?user=Wwcc5-8AAAAJ&hl=en>
Interest area: Virology

Girija Regmi - Department of Cardiovascular Biology, Oklahoma Medical Research Foundation, Oklahoma City, Oklahoma, USA
<https://orcid.org/0000-0001-6827-3783>
Google Scholar profile: <https://scholar.google.com/citations?user=JRhk5-sAAAAJ&hl=en>
Interest area: Anatomy - Animal Hygiene, Husbandry, Nutrition, and Food Control - Animal Nutrition - Animal Reproduction - Animal Science - Antimicrobial resistance - Bacteriology - Biological Sciences - Biomedical Sciences - Hematology - Immunohistochemistry - Microbiology - Molecular Biology - Veterinary Anatomy, Histology, and Physiology - Veterinary Medicine - Veterinary Medicine and Infectious Diseases - Veterinary Pathology - Veterinary Science - Zoonoses

Widya Paramita Lokapirnasari - Professor, Department of Animal Husbandry, Airlangga University, FKH, Kampus C Unair, Jl Mulyorejo, Surabaya, Indonesia
<https://orcid.org/0000-0002-0319-7211>
Google Scholar profile: <https://scholar.google.co.id/citations?user=eS3yVQQAAAAJ&hl=id>
Interest area: Animal Nutrition - Cattle Husbandry - Feed Supplements - Polymerase Chain Reaction - Poultry Husbandry - Probiotics

Ayman Abdel-Aziz Swelum - Professor of Theriogenology, Faculty of Veterinary Medicine, Zagazig University, Zagazig, Egypt; Department of Animal Production, College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia
<http://orcid.org/0000-0003-3247-5898>
Google Scholar profile: <https://scholar.google.com/citations?user=OZTI3poAAAAJ&hl=en>
Profile: <http://www.staffdata.zu.edu.eg/en/ShowData/18313>
<https://faculty.ksu.edu.sa/ar/aswelum>
Interest area: Animal Reproduction - Animal Production - Embryo transfer - Artificial Insemination

Mario Manuel Dinis Ginja Department of Veterinary Sciences, Center for Research and Agro-Environmental and Biological Technologies, University of Trás-os-Montes and Alto Douro, Portugal
<https://orcid.org/0000-0002-0464-7771>
Publons profile: <https://publons.com/researcher/1180094/mario-manuel-dinis-ginja/>
Interest area: Orthopaedics - Radiology (Diagnostic) - Sonography - Veterinary Medicine - Veterinary Science

Panagiotis E Simitzis - Laboratory of Animal Breeding and Husbandry, Department of Animal Science, Agricultural University of Athens, 75 Iera Odos, 11855, Athens, Greece
<http://orcid.org/0000-0002-1450-4037>
Google Scholar profile: <https://scholar.google.com/citations?user=14F6cAQAAAAJ&hl=en>
Interest area: Dietary Antioxidants - Feed Supplements - Animal Behaviour - Animal Welfare - Livestock Management - Poultry Husbandry - Sheep Husbandry - Swine Husbandry - Products' Quality Assessment

Gul Ahmad - Associate Professor of Biology (Tenured), Department of Natural Sciences, School of Arts & Sciences, Peru State College, Peru, Nebraska 68321, USA
Google Scholar profile: <https://scholar.google.com/citations?user=WOIDNKUAAAAJ&hl=en>

Bartosz Kieronczyk - Poznan University of Life Sciences, Poznan, Greater Poland, Poland
<https://orcid.org/0000-0001-6006-117X>
Google Scholar profile: <https://scholar.google.pl/citations?user=SyprUmAAAAJ&hl=en>
Interest area: Animal Nutrition - Animal Science - Antimicrobial resistance - Aquaculture - Feed Supplements - Livestock Management - Livestock Products Technology - Microbiology - Physiology - Poultry Science - Waste Management of Agro Products

Alberto Elmi - University of Bologna, Ozzano dell'Emilia, Bologna, Italy
<https://orcid.org/0000-0002-7827-5034>
Google Scholar profile: <https://scholar.google.it/citations?user=ej4LzNgAAAAJ&hl=it>
Interest area: Animal Reproduction - Laboratory Animal Research - Laboratory Medicine - Physiology - Swine Medicine - Wildlife

Editorial board

Suresh H. Basagoudanavar - FMD Vaccine Research Laboratory, Indian Veterinary Research Institute, Bangalore- 560024, Karnataka, India
<https://orcid.org/0000-0001-7714-3120>
ResearchGate profile: <https://www.researchgate.net/profile/Suresh-Basagoudanavar>
Interest area: Biotechnology - Immunology - Virology

Gyanendra Gongal - Senior Public Health Officer (Food safety, zoonoses and One Health). World Health Emergency Programme, WHO Regional Office for south East Asia, New Delhi, India
<https://orcid.org/0000-0002-6539-7569> Google Scholar profile:
<https://scholar.google.com/citations?user=XNCypDcAAAAJ&hl=en>
Interest area: Public Health - Zoonoses - One Health

Md. Tanvir Rahman - Department of Microbiology and Hygiene, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
<https://orcid.org/0000-0001-5432-480X>
Google Scholar profile: <https://scholar.google.com/citations?user=vp6xgh0AAAAJ&hl=en>
Interest area: Antimicrobial resistance - Virulence-Food hygiene- Public Health - Vaccine - One Health

Fouad Kasim Mohammad - Professor Emeritus, Pharmacology & Toxicology, College of Veterinary Medicine, University of Mosul, Mosul, Iraq
Google Scholar profile: <https://scholar.google.com/citations?user=zgCIA4UAAAAJ&hl=en>
Interest area: Pharmacology - Toxicology

Joao Simoes - Universidade de Tras-os-Montes e Alto Douro, Vila Real, Portugal
<https://orcid.org/0000-0002-4997-3933>
Google Scholar profile: <https://scholar.google.com/citations?user=ftLFW-sAAAAJ&hl=en>
Interest area: Large Animal Medicine - Mastitis - Reproductive medicine - Veterinary Medicine

Abdelaziz ED-DRA - Department of Biology, Faculty of Science, Moulay Ismail University, BP. 11201 Zitoune, Meknes, Morocco
<https://orcid.org/0000-0003-3273-1767>
Google Scholar profile: <https://scholar.google.com/citations?user=ftL-1V0AAAAJ&hl=en>
Interest area: Antimicrobial resistance - Clinical Microbiology - Food - Food/Meat Hygiene - Polymerase Chain Reaction

Filippo Giarratana - Department of Veterinary Medicine, University of Messina, Polo Universitario dell'Annunziata, 98168 Messina, Italy
<https://orcid.org/0000-0003-0892-4884>
Google Scholar profile: <https://scholar.google.com/citations?user=lut-WbIAAAAAJ&hl=it>
Interest area: Antimicrobial resistance - Bacteriology - Food/Meat Hygiene - Plant Science - Essential oils

Eduardo Jorge Boeri - Institute of Zoonosis Luis Pasteur, Buenos Aires, Argentina
<https://orcid.org/0000-0001-8535-0306>
Google Scholar profile: https://scholar.google.com/citations?user=aerl_4oAAAAJ&hl=en&oi=sra
Interest area: Brucellosis - Microbiology - Veterinary Medicine - Veterinary Public Health - Zoonoses

Kumar Venkitanarayanan - Graduate Programs Chair, Honors and Pre-Vet Programs Advisor, Department of Animal Science, University of Connecticut, Storrs, CT 06269, USA
Google Scholar profile: <https://scholar.google.com/citations?hl=en&user=Nr9CY28AAAAJ>
Interest area: Bacteriology - Clinical Microbiology - Infectious Diseases - Veterinary Medicine

Karim El-Sabrou - Poultry Production Department, Alexandria University, Alexandria, Egypt
<https://orcid.org/0000-0003-2762-2363>

Google Scholar profile: <https://scholar.google.com/citations?hl=en&user=q-1jH8AAAAAJ>

Interest area: Poultry Husbandry

Ali Aygun - Selçuk University, Agriculture Faculty, Department of Animal Science, Konya, TURKEY

<https://orcid.org/0000-0002-0546-3034>

Google Scholar profile: <https://scholar.google.com/citations?hl=en&user=nZsp5iAAAAAJ>

Interest area: Poultry Husbandry - Poultry Medicine

Ionel D. Bondoc - Associate Professor, Department of Public Health, Faculty of Veterinary Medicine Iasi, University of Life Sciences "Ion Ionescu de la Brad" Iasi, Romania

<https://orcid.org/0000-0002-5958-7649>

Google Scholar profile: <https://scholar.google.ro/citations?user=-dUf6oYAAAAAJ&hl=ro>

Publons Profile: <https://publons.com/researcher/741287/ionel-bondoc/>

Interest area: Dairy Science - Epidemiology - Food Science - Food Technology - Food Law - One Health - Parasitology - Meat Inspection - Pathogens - Foodborne Diseases - Food Toxicology - Veterinary Public Health - Wildlife Diseases - Zoonoses

Liliana Aguilar-Marcelino - National Center for Disciplinary Research in Animal Health and Safety, National Institute for Agricultural and Livestock Forestry Research, Mexico

<https://orcid.org/0000-0002-8944-5430>

Google Scholar profile: <https://scholar.google.ro/citations?hl=ro&user=ZbMMp-UAAAAAJ>

Interest area: Biology - Ethnoveterinary - Parasitology - Veterinary Medicine - Veterinary Public Health

Anut Chantiratikul - Department of Agricultural Technology, Faculty of Technology, Mahasarakham University, Muang, Mahasarakham Province 44150 Thailand

<https://orcid.org/0000-0002-8313-5802>

Google Scholar profile: <https://scholar.google.ro/citations?hl=ro&user=QogjWpgAAAAAJ>

Interest area: Biology - Animal Nutrition

Nuh Kilic - Department of Surgery, Faculty of Veterinary Medicine, Adnan Menderes University, Turkey

<https://orcid.org/0000-0001-8452-161X>

Google Scholar profile: <https://scholar.google.ro/citations?hl=ro&user=APVrx1cAAAAAJ>

Interest area: Large Animal Medicine - Surgery - Veterinary Medicine

Hanna Markiewicz - Milk Examination Laboratory, Kazimierz Wielki University in Bydgoszcz, Poland

<https://orcid.org/0000-0001-8225-0481>

ResearchGate profile: <https://www.researchgate.net/scientific-contributions/H-Markiewicz-10381112>

Interest area: Large Animal Medicine - Mastitis

N. De Briyne - Federation of Veterinarians of Europe, Brussels, Belgium

<https://orcid.org/0000-0002-2348-930X>

Google Scholar profile: <https://scholar.google.ro/citations?>

hl=ro&user=BOhfORAAAAAJ

Interest area: Animal Science - Antimicrobial resistance

Hasan Meydan - Akdeniz University, Faculty of Agriculture, Antalya, Turkey

<https://orcid.org/0000-0003-4681-2525>

Google Scholar profile: [https://scholar.google.ro/citations?](https://scholar.google.ro/citations?hl=ro&user=T2uHga0AAAAJ)

hl=ro&user=T2uHga0AAAAJ

Interest area: Biotechnology - Genetics - Veterinary Medicine

Suleyman Cilek - Kirikkale Universitesi, Kirikkale, kirikkale, Turkey

<https://orcid.org/0000-0002-2352-649X>

ResearchGate profile: <https://www.researchgate.net/scientific-contributions/Suleyman-Cilek-2092525513>

Interest area: Animal Nutrition - Animal Nutrition - Animal Reproduction - Animal Reproduction - Animal Reproduction - Breeding - Cattle Husbandry - Cattle/buffalo management - Equine Medicine - Genetics - Livestock Management - Mastitis - Molecular Genetics - Poultry Husbandry - Poultry Husbandry - Sheep Husbandry - Sheep Husbandry - Small Animal Medicine - Swine Husbandry - Veterinary Medicine

Rodrigo Alberto Jerez Ebensperger - University of Zaragoza, Spain

Interest area: Animal Reproduction - Artificial Insemination - Biotechnology - Breeding - Embryo Transfer Technology - Equine Medicine - Large Animal Medicine - Livestock Management - Small Animal Medicine - Veterinary Medicine - Wildlife

Parag Nigam - Department of Wildlife Health Management, Wildlife Institute of India, Dehradun, India

ResearchGate profile: <https://www.researchgate.net/profile/Parag-Nigam>

Interest area: Veterinary Medicine - Veterinary Public Health - Wildlife - Zoonoses

Alessandra Pelagalli - Department of Advanced Biomedical Sciences, University of Naples Federico II, Italy

<https://orcid.org/0000-0002-1133-4300>

Google Scholar profile: [https://scholar.google.ro/citations?](https://scholar.google.ro/citations?hl=ro&user=T1iZqmMAAAAJ)

hl=ro&user=T1iZqmMAAAAJ

Interest area: Physiology

Jamal Gharekhani - Senior researcher, Iranian Veterinary Organization (IVO), Hamedan, Iran

<https://orcid.org/0000-0001-5882-8861>

Google Scholar profile: <https://scholar.google.ro/citations?hl=ro&user=vlhjoBEAAAAJ>

Interest area: Parasitology - Pathobiology - Veterinary Public Health

Ipsita Mohanty - Postdoctoral Research Fellow, Children's Hospital of Philadelphia Research Institute, (CHOP), Philadelphia

<https://orcid.org/0000-0003-0894-4770>

Google Scholar profile: [https://scholar.google.ro/citations?](https://scholar.google.ro/citations?hl=ro&user=anWIO7IAAAAJ)

hl=ro&user=anWIO7IAAAAJ

Interest area: Pharmacology - Toxicology - Physiology - Cardiology

Alejandro Hidalgo - Preclinical Science Department, Faculty of Medicine, Universidad de La Frontera, Temuco, Chile

<https://orcid.org/0000-0002-2247-4878>

Google Scholar profile: [https://scholar.google.ro/citations?](https://scholar.google.ro/citations?hl=ro&user=5vejgSAAAAAJ)

hl=ro&user=5vejgSAAAAAJ

Interest area: Zoonotic parasitic diseases - Parasite phylogeny - Zoology - Parasitology

Hua-Ji Qiu - Professor, Harbin Veterinary Research Institute (HVRI), Chinese Academy of Agricultural Sciences (CAAS), Harbin, Heilongjiang, 150069, P.R. China
<https://orcid.org/0000-0003-4880-5687>

Profile:

http://www.hvri.ac.cn/zzjg/cxtd/zlxzrbcxtd/sx_20180726100149743651/index.htm

Interest area: Classical swine fever - African swine fever - Pseudorabies - Innate and adaptive immunity - Virus-host interactions - Pathogenesis - Epidemiology - Vaccines - Diagnostic assays - Probiotics

Hasria Alang - Biology Lecturer at STKIP-PI Makassar, Makassar, Indonesia
<https://orcid.org/0000-0001-9393-9575>

Google Scholar profile: [https://scholar.google.ro/citations?](https://scholar.google.ro/citations?hl=ro&user=NpwjancAAAAJ)

[hl=ro&user=NpwjancAAAAJ](https://scholar.google.ro/citations?hl=ro&user=NpwjancAAAAJ)

Interest area: Microbiology - Molecular Biology

Belgin Siriken - Professor, Department of Water Products Diseases, Faculty of Veterinary Medicine, Ondokuz Mayıs University, Kurupelit Campus, 55200 Samsun, Turkey

<https://orcid.org/0000-0002-5793-1792>

Google Scholar profile: [https://scholar.google.ro/citations?](https://scholar.google.ro/citations?hl=ro&user=JpuWvaUAAAAJ)

[hl=ro&user=JpuWvaUAAAAJ](https://scholar.google.ro/citations?hl=ro&user=JpuWvaUAAAAJ)

Interest area: Food - Food science - Food Technology - Food borne diseases - Antibiotic resistance - One Health - Veterinary Public Health

Hussein Awad Hussein - Professor of Internal Veterinary Medicine, Department of Animal Medicine, Faculty of Veterinary Medicine, Assiut University, Assiut 71526, Egypt

<https://orcid.org/0000-0003-0449-8283>

Google Scholar profile: <https://scholar.google.ro/citations?hl=ro&user=oJySPI8AAAAJ>

Interest area: Internal Medicine - Spectrophotometry - Ultrasonography - Parasitological analysis - Blood gas analysis - Metabolic profiling - Veterinary Medicine - Large Animal Medicine - Equine Medicine - Mastitis

Tanko Polycarp Nwunuji - Senior lecturer, Department of Veterinary Microbiology and Pathology, Faculty of Veterinary Medicine, University of Jos, Plateau State, Nigeria

<https://orcid.org/0000-0003-1459-2564>

Google Scholar profile: [https://scholar.google.ro/citations?](https://scholar.google.ro/citations?hl=ro&user=MD7ehVwAAAAJ)

[hl=ro&user=MD7ehVwAAAAJ](https://scholar.google.ro/citations?hl=ro&user=MD7ehVwAAAAJ)

Interest area: Clinical and Anatomic Pathology - Oncology - Fisheries with special interest in bacterial diseases of fishes and other diseases associated with aquaculture management - Diseases of small and large ruminants - Laboratory animal medicine - Diseases of Dogs, horses and pigs as well as non-infectious diseases such as Diabetes and stress-induced pathologies

Md. Ahaduzzaman - Associate Professor, Department of Medicine and Surgery, Faculty of Veterinary Medicine, Chittagong Veterinary and Animal Sciences University, Bangladesh

<https://orcid.org/0000-0002-0568-0506>

Google Scholar profile: [https://scholar.google.ro/citations?](https://scholar.google.ro/citations?hl=ro&user=u6x_8FkAAAAJ)

[hl=ro&user=u6x_8FkAAAAJ](https://scholar.google.ro/citations?hl=ro&user=u6x_8FkAAAAJ)

Interest area: Antimicrobial resistance - Infectious Diseases - Poultry Medicine - Veterinary Medicine - Veterinary Microbiology and Parasitology - Veterinary Public Health - Veterinary Science - Meta-analysis - Phylogenetic analysis

Vanessa S. Cruz - Professor, Department of Veterinary Medicine, Catholic University Center of East Minas (Unileste), Avenue President Tancredo de Almeida Neves, 3500, University District, Coronel Fabriciano - MG, Brazil
<https://orcid.org/0000-0002-8914-5964>
Profile: <http://lattes.cnpq.br/8788967925940484>
Interest area: Cancer - Molecular Biology - Veterinary Medicine - Veterinary Pathology - Small Animal Clinic and Surgery (oncology, geriatrics, breeding and behavior of dogs and cats)

R.Umaya Suganthi - Principal Scientist, ICAR-National Institute of Animal Nutrition and Physiology (ICAR-NIANP), Government of India, Bangalore 560 030, Karnataka, India
<https://orcid.org/0000-0002-7710-6271>
Google Scholar Profile: <https://scholar.google.co.in/citations?user=6VEZ7XMAAAJ&hl=en>
Interest area: Antimicrobial resistance - Antibiotic growth promoters in poultry and their alternatives - Phytochemicals - Oxidative stress and antioxidants - Mycotoxin toxicity and amelioration - Selenium and selenoproteins
Last updated on 23-03-2022

Site Links

Editorial board (<http://www.veterinaryworld.org/editorial.html>)
Instruction for authors
(<http://www.veterinaryworld.org/manuscript.html>)
Author declaration certificate
([http://www.veterinaryworld.org/author declaration certificate.pdf](http://www.veterinaryworld.org/author%20declaration%20certificate.pdf))
Tutorial for online submission
(http://my.ejmanager.com/scopemed_tutorial_authors.pdf)
Manuscript template
(<http://www.veterinaryworld.org/Manuscripttemplate.pdf>)
Submit your manuscript (<http://my.ejmanager.com/vetworld/>)
FAQ (<http://www.veterinaryworld.org/FAQ.html>)
Reviewer guidelines ([http://www.veterinaryworld.org/Reviewer guideline.pdf](http://www.veterinaryworld.org/Reviewer%20guideline.pdf))
Open access policy (<http://www.veterinaryworld.org/subscription.html>)
Most cited articles (<http://scholar.google.co.in/citations?hl=en&authuser=1&user=vWiG7DoAAAAJ>)
Archive (<http://www.veterinaryworld.org/tableofcontent.html>)

Editorial Office

Veterinary World Star, Gulshan Park, NH-8A, Chandrapur Road,
Wankaner - 363621, Dist. Morbi (Gujarat), India
E-mail: editorveterinaryworld@gmail.com
Website: www.veterinaryworld.org

Editor-in-Chief

Dr. Anjum V. Sherasiya
E-mail: editorveterinaryworld@gmail.com

Detection of *invA* virulence gene of multidrug-resistant *Salmonella* species isolated from the cloacal swab of broiler chickens in Blitar district, East Java, Indonesia

Freshindy Marissa Wibisono¹, Hayyun Durrotul Faridah², Freshinta Jellia Wibisono³, Wiwiek Tyasningsih⁴, Mustofa Helmi Effendi⁵, Adiana Mutamsari Witaningrum⁵ and Emmanuel Nnabuike Ugbo⁶

1. Department of Veterinary Public Health, Faculty of Veterinary Medicine, Universitas Airlangga, Surabaya, Indonesia;
2. Department of Biology, Faculty of Science and Technology, Universitas Airlangga, Surabaya, Indonesia;
3. Department of Veterinary Public Health, Faculty of Veterinary Medicine, Wijaya Kusuma University Surabaya, Surabaya, Indonesia;
4. Department of Veterinary Microbiology, Faculty of Veterinary Medicine, Universitas Airlangga, Surabaya, Indonesia;
5. Department of Veterinary Public Health, Faculty of Veterinary Medicine, Universitas Airlangga, Surabaya, Indonesia;
6. Department of Applied Microbiology, Ebonyi State University, Abakaliki, Nigeria.

Corresponding author: Mustofa Helmi Effendi, e-mail: mheffendi@yahoo.com

Co-authors: FMW: freshindymw@gmail.com, HDF: hayyun.durrotul.faridah-2019@fst.unair.ac.id, FJW: freshinta.uwks@gmail.com, WT: witya_kh@yahoo.com, AMW: adiana_mutam@yahoo.co.id, ENU: ugbonuel2001@yahoo.com

Received: 23-06-2021, **Accepted:** 02-11-2021, **Published online:** 19-12-2021

doi: www.doi.org/10.14202/vetworld.2021.3126-3131 **How to cite this article:** Wibisono FM, Faridah HD, Wibisono FJ, Tyasningsih W, Effendi MH, Witaningrum AM, Ugbo EN (2021) Detection of *invA* virulence gene of multidrug-resistant *Salmonella* species isolated from the cloacal swab of broiler chickens in Blitar district, East Java, Indonesia, *Veterinary World*, 14(12): 3126-3131.

Abstract

Background and Aim: The increasing number of multidrug-resistant (MDR) *Salmonella* species on poultry farms in Indonesia has caused concern regarding human health. This study was conducted to determine the presence of the virulence gene *invA* in MDR *Salmonella* species isolated from the cloacal swab of broiler chickens in Blitar district, East Java Province, Indonesia.

Materials and Methods: Cloacal swab samples were collected by purposive sampling from 15 farms in four districts. Isolation and identification of bacteria were performed using standard microbiological techniques. Confirmation of MDR isolates was done using five different classes of antibiotics, including the beta-lactam, aminoglycoside, fluoroquinolone, phenicol, and monobactam groups. An antibiotic susceptibility test was conducted using the Kirby–Bauer disk diffusion method, and a polymerase chain reaction method was used to screen for the presence of *invA*.

Results: It was observed that 32.26% (50/155) of the samples were positive for *Salmonella* species. Of these 50 *Salmonella* isolates, 7 (14%) were identified as MDR strains. An important finding was the detection of *invA* in all the seven MDR *Salmonella* strains (100%) isolated from the cloacal swab of broiler chickens in Blitar district, East Java Province.

Conclusion: Veterinarians have an extremely important role in monitoring the use of antibiotics in farm animals to mitigate the rapid spread of MDR organisms in our environment, which can otherwise cause serious economic losses and also public health issues.

Keywords: broiler chicken, *invA* gene, multidrug-resistant, public health, *Salmonella*.

Introduction

Salmonella species have been the major cause of foodborne diseases in several countries in the past 100 years [1-3]. It has been reported worldwide that there are 1.6 million cases of typhoid fever, 1.3 billion cases of gastroenteritis, and 3 million deaths due to *Salmonella* species [4]. Salmonellosis is a disease caused by the pathogenic agent *Salmonella* spp. Salmonellosis has been categorized as an important public health zoonosis [5-7] with a high morbidity rate and is difficult to prevent [8,9]. *Salmonella* species

have several virulence factors that are important in the process of infection in the host and spread of disease. Most virulence factors are located in chromosomal genes known as *Salmonella* pathogenicity islands (SPIs). SPIs are essential for invasion and proliferation in host cells [10,11].

Chromosomal virulence genes comprise *invA*, *invE*, *himA*, and *phoP*, which are included among the target genes for polymerase chain reaction (PCR) amplification in *Salmonella* spp. [12,13]. *Salmonella* spp. harbor *invA* that plays a role in causing illness. More than 50% of these serotypes are *Salmonella enterica*, which accounts for the majority of human *Salmonella* infections [3]. This gene is located in the area of SPI, which has an operon that functions as a repository for genetic information [14]. *invA* from *Salmonella* spp. contains a unique DNA sequence and has been confirmed to be a suitable PCR target gene for the detection of *Salmonella* spp. [15]. This gene encodes proteins in

Copyright: Wibisono, et al. Open Access. This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated.

bacterial cell membranes that are required for invasion into host epithelial cells [16]. *In vitro* amplification of DNA by the PCR method is an accurate tool for microbiological diagnosis [17].

Blitar has the largest chicken farms in East Java province, which consists of layer and broiler farms [18]. This high population enables the development of several diseases. The incidence of infection with *Salmonella* species is caused by contact with animals [9,19]. Infection can be acquired by both direct and indirect contact with animals [20]. Due to the increasing incidence of infectious diseases, antibiotic use has become the most predominant strategy in health services [21,22]. Such high use of antibiotics has resulted in an increase in antibiotic resistance [23].

This study was conducted to determine the presence of the virulence gene *invA* in multidrug-resistant (MDR) *Salmonella* species isolated from the cloacal swab of broiler chickens in Blitar district, East Java Province, Indonesia.

Materials and Methods

Ethical approval

Ethical approval was not necessary. However, cloacal swab samples were collected as per the standard collections method without any harm to the broiler.

Study period and location

This research was conducted from October 2020 to February 2021. Samples were collected from 15 broiler farms in Blitar district. The farms are located in four sub-districts, namely Ponggok, Garum, Selopuro, and Selorejo sub-districts. Samples were processed at Laboratory of Department of Veterinary Public Health, Faculty of Veterinary Medicine, Universitas Airlangga.

Sample collection

The sampling technique was carried out by purposive sampling from broiler farms that had been determined by the researchers with criteria, namely, information from the relevant agencies, and broiler chickens that had clinical digestive symptoms such as diarrhea, abnormal stool color, weakness, and dirty parts around the cloaca. Samples were taken from the cloacal swab of broiler chickens in Blitar district [24]. The sample size used was 155 cloacal swab samples from 15 broiler farms on four sub-districts (Figure-1) [25].

Bacterial isolates

Bacterial testing included isolation and identification of *Salmonella* isolates. Bacterial isolation was conducted by collecting a suspension using an inoculation loop sterilized under a Bunsen burner fire.

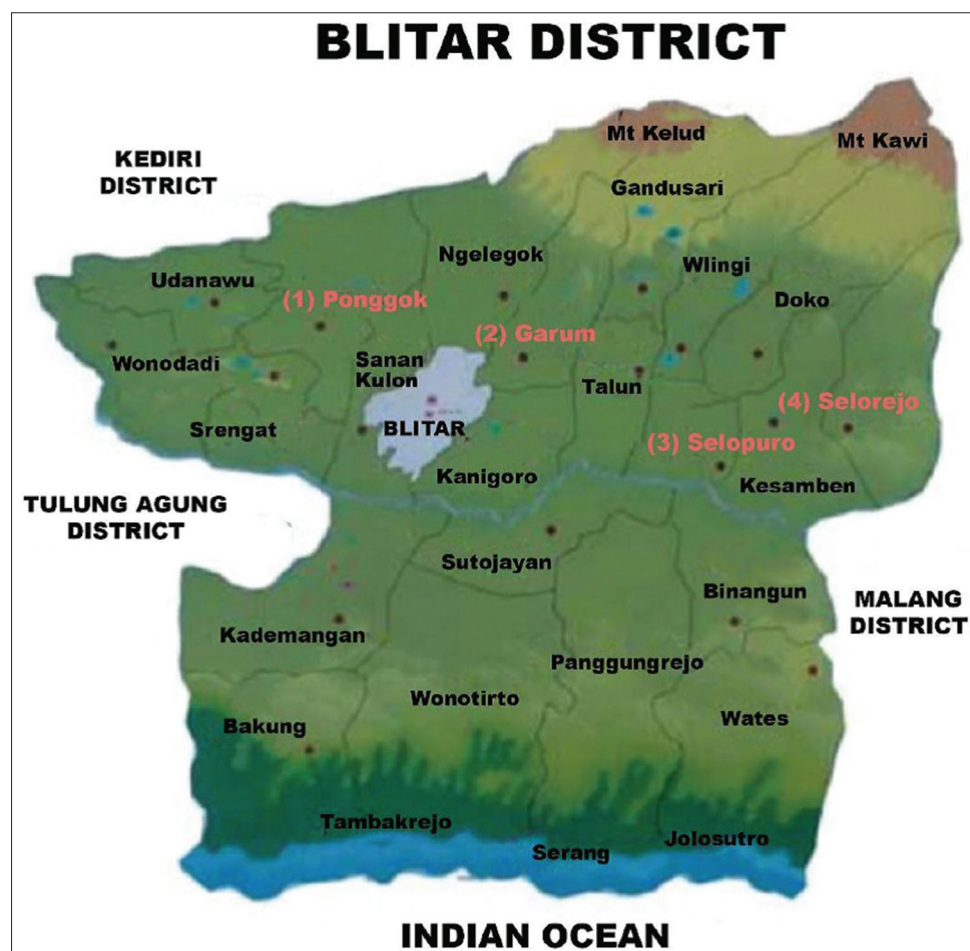


Figure-1: Map of the distribution of sampling in Blitar district. (1) Ponggok subdistrict; (2) Garum subdistrict; (3) Selopuro subdistrict; and (4) Selorejo subdistrict [25].

The suspension was implanted in *Salmonella*-*Shigella* agar (Figure-2). *Salmonella* growth produces a transparent or colorless colony with a black center due to the formation of H₂S gas. Presumptive *Salmonella* was placed on bismuth sulfite agar media. Bismuth sulfite is a selective medium for the isolation of *Salmonella* in the laboratory and is generally used for the detection of *Salmonella* species.

Antibiotic sensitivity test

All *Salmonella* spp. isolates were subjected to the antibiotic sensitivity test, and confirmation of MDR isolates was done using antibiotic sensitivity tests to five different classes of antibiotics. The following antibiotic disks (Oxoid, England) were used: Beta-lactam (amoxicillin 10 g), aminoglycoside (gentamicin 10 g), quinolone (ciprofloxacin 5 g), phenicol (chloramphenicol 30 g), and monobactam (aztreonam 30 g) groups.

PCR amplification of *invA*

All the MDR *Salmonella* spp. were tested for the presence of the virulence gene *invA* [26,27]. This gene is responsible for the virulence factor of

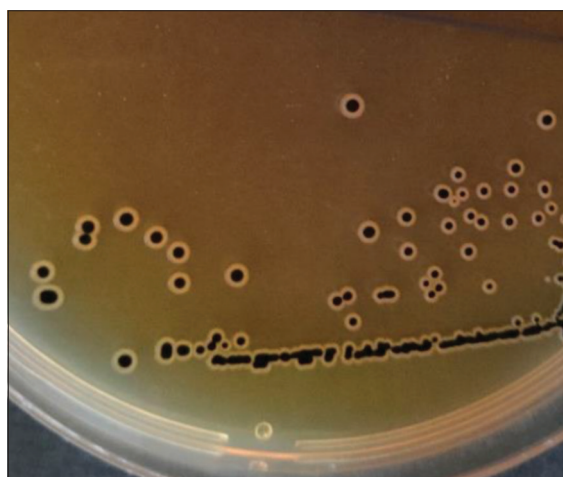


Figure-2: Pure colonies of *Salmonella* spp. on SSA media.

Table-1: Isolation and identification of *Salmonella* species on Blitar district.

Subdistrict	Samples	<i>Salmonella</i> spp.	Percentage
Ponggok	53	15	28.30
Garum	25	15	60.00
Selopuro	51	14	27.45
Selorejo	26	6	23.08
Total	155	50	32.26

Salmonella spp. The specific primers used to detect *invA* in *Salmonella* isolates have been previously published [16], which included the forward primer 5' GTG AAA TTA TCG CCA CGT TCG GGC AA 3' and the reverse primer 5' TCA TCG CAC CGT CAA AGG AAC C 3' (284 bp). This study was conducted at the Veterinary Public Health Laboratory, Faculty of Veterinary Medicine, Universitas Airlangga, and the Microbiology Laboratory of the Central Health Laboratory, Surabaya. In the PCR analysis, *Escherichia coli* isolate ATCC 25922 was used as a negative control, and *Salmonella* Paratyphi A isolate ATCC 9150 was used as a positive control, which had been previously tested for the presence of *invA*.

Results and Discussion

Salmonella species remains one of the major causes of foodborne diseases such as salmonellosis and other related diarrhea in several countries in the world [3]. The findings of this study indicated that 32.26% (50/155) of the samples were positive for *Salmonella* isolates (Table-1). The highest incidence occurred in Garum subdistrict (60.00%), followed by Ponggok (28.30%) and Selopuro (27.45%) subdistricts, and the lowest incidence occurred in Selorejo subdistrict (23.08%). These results indicated the presence of high infection with *Salmonella* spp. in Blitar district. The overall incidence is much higher than that of the previous studies, which reported an incidence of 3.2% in layer chickens and 12.4% in broiler chickens from five provinces in Java [28]; however, the incidence of salmonellosis in layer chicken farms in Sidrap district was 76.39% [29]. Our study findings indicate the need for increased attention toward an immediate follow-up by relevant policymakers as an effort to prevent the spread of zoonotic diseases [30]. Salmonellosis is a zoonotic disease caused by *Salmonella* spp., which can affect humans and animals. Indirect transmission can occur through contact with the environment around animals or with contaminated objects around poultry farms [6,31].

The high incidence of salmonellosis in Garum subdistrict compared to that in the other three subdistricts is due to the relatively low sanitation in poultry farms. In general, the farm is located behind the farmer's house. Field conditions showed the sewerage from the farmer's house is adjacent to the cage. Contamination and infection with *Salmonella* spp. on a farm with poor

Table-2: Multidrug resistance of *Salmonella* spp. on broiler chicken.

Location	<i>Salmonella</i> spp.	Beta-lactam		Aminoglycoside		Quinolone		Phenicol		Monobactam		Multidrug resistant	
		R	%	R	%	R	%	R	%	R	%	Total	%
Ponggok	15	5	33.3	4	26.7	3	20	2	13.3	0	0	0	0.00
Garum	15	5	33.3	2	13.3	6	40	2	13.3	0	0	3	20.00
Selopuro	14	8	57.1	4	28.6	11	78.6	0	0	0	0	3	21.43
Selorejo	6	4	66.7	2	33.3	3	50	2	33.3	0	0	1	16.67
Total	50	22	44	12	24	23	46	6	12	0	0	7	14

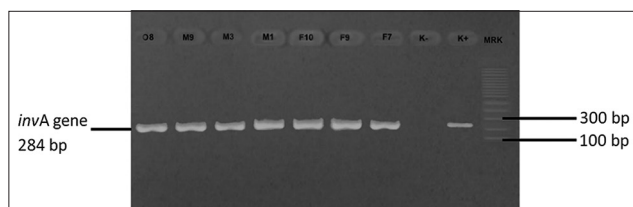


Figure-3: Gene *invA* of *Salmonella* spp. multidrug-resistant isolates. K+=*Salmonella* Paratyphi A ATCC 9150 as positive control; K-=*E. coli* ATCC 25922 as negative control; F7, F9, F10, M1, M3, M9, and O8=Multidrug-resistant isolates.

sanitation can occur due to the spread of *Salmonella* spp. through contaminated feces, thereby contaminating feed, drinking water, and hatching eggshells [28].

Salmonellosis can be treated using antibiotics. The emergence of MDR *Salmonella* species has now received the attention of various researchers. MDR indicates the resistance of bacteria to three or more classes of antibiotics [32]. Such resistance to some of these antibiotics can occur due to the pattern of continuous use of antibiotics in the livestock industry as both treatment and feed additives and growth promoters. The continuous use of antibiotics is a triggering factor for high levels of antibiotic resistance [33,34].

In this study, quinolone and beta-lactam exhibited the highest yields of 46% and 44%, respectively (Table-2). This is because these classes of antibiotics are often used in broiler farms in Blitar district. Fluoroquinolones have a very narrow safety range and are safe in low or high doses but for a short time. Continuous use for prolonged periods can cause side effects [35]. Beta-lactams are the most widely used class of antibiotics in both human clinical practice and veterinary medicine because they are broad-spectrum antibiotics and exhibit a very good level of safety [34]. Routine administration of broad-spectrum antibiotics is one of the supporting factors for the changing patterns of resistance to various antibiotics [36]. Cases of antibiotic resistance in bacteria can be caused by a lack of supervision on the use of antibiotics in farms, as 72.3% of farmers use antibiotics without veterinary supervision [37]. Risk factors such as the broiler breed, breeder education, type of partnership business, type of factory feed, veterinarian support in livestock rearing management, cage hygiene sanitation, chlorine treatment of drinking water, the existence of an antibiotic program, and reference to the use of antibiotics are positively associated with the incidence of MDR in chicken farms [38,39].

The findings of this study showed that seven *Salmonella* isolates were MDR (Table-2), as they were resistant to three different classes of antibiotics. MDR is caused by the continuous use of one type of antibiotic by the farmers. However, no single isolate was collectively resistant to the same antibiotic class. The existence of a rotation program in the administration of antibiotics can prevent the incidence of antibiotic resistance. Hence, it is necessary to educate

farmers on the use of different antibiotics or the rotation of antibiotics during disease treatment. The role of veterinarians is also extremely important in monitoring the use of antibiotics on farms. Antibiotics must be used wisely and in the correct dose, and not as a disease prevention strategy [38,40,41].

Our results also confirmed the presence of the virulence gene *invA* in all the seven (100%) MDR *Salmonella* isolates using *invA*-specific primers (Figure-3). In all these isolates, *invA* was successfully amplified at 284 bp. This finding indicated that it is difficult to treat salmonellosis caused by MDR isolates because they have the ability to be pathogenic as evidenced by the presence of *invA*. This gene encodes membrane proteins in bacteria that are responsible for invading host intestinal cells [42,43]. In *Salmonella* isolates, *invA* was located in SPI-1, which plays an extremely important role in the invasion of host epithelial cells. This gene is highly specific for most *Salmonella* species [44,45]. *Salmonella* spp. harbors numerous virulence factors, which is one of the causes for the high incidence of salmonellosis in humans and animals. Intensive use of antibiotics for salmonellosis treatment leads to the emergence of resistant bacteria. One of the best assays for identifying virulence genes is PCR [46,47].

Conclusion

In total, 32.26% (50/155) of the samples were positive for *Salmonella* species. Of the 50 isolates, 7 (14%) were found to be MDR. The virulence gene *invA* was identified in all the seven MDR *Salmonella* strains (100%) isolated from the cloacal swab of broiler chickens in Blitar district, East Java Province. Veterinarians have an extremely important role in monitoring the use of antibiotics in farm animals to mitigate the rapid spread of MDR organisms in our environment, which can otherwise cause serious economic losses and also public health issues.

Authors' Contributions

MHE, FMW, and FJW: Conceptualization. MHE, FMW, and HDF: Data curation. WT and AMW: Formal analysis. MHE and WT: Funding acquisition. FMW, HDF, and FJW: Investigation. MHE and AMW: Methodology. MHE and AMW: Project administration. MHE, FMW, and FJW: Resources. MHE and WT: Supervision. MHE, WT, and ENU: Validation. FMW and AMW: Visualization. MHE, FMW, and FJW: Writing original draft. MHE and ENU: Review and editing. All authors read and approved the final manuscript.

Acknowledgments

We would like to thank Blitar Animal Husbandry Office, Indonesia, for their help in the data collection used in this study. This study was funded by Universitas Airlangga, Indonesia (Grant number 420/UN3.15/PT/2021).

Competing Interests

The authors declare that they have no competing interests.

Publisher's Note

Veterinary World remains neutral with regard to jurisdictional claims in published map and institutional affiliation.

References

- Dos Santos, A.M.P., Ferrari, R.G. and Conte-Junior, C.A. (2019) Factors in *Salmonella* Typhimurium: The sagacity of a bacterium. *Curr. Microbiol.*, 76(6): 762-773.
- Lee, K.M., Runyon, M., Herrman, T.J., Phillips, R. and Hsieh, J. (2015) Review of *Salmonella* detection and identification methods: Aspects of rapid emergency response and food safety. *Food Control.*, 47(1): 264-276.
- Wibisono, F.M., Wibisono, F.J., Effendi, M.H., Plumeriastuti, H., Hidayatullah, A.R., Hartadi, E.B. and Sofiana, E.D. (2020) A review of salmonellosis on poultry farms: Public health importance. *Syst. Rev. Pharm.*, 11(9): 481-486.
- Pui, C.F., Wong, W.C., Chai, L.C., Tunung, R., Jeyaletchumi, P., Noor Hidayah, M.N., Ubong, A., Farinazleen, M.G., Cheah, Y.K. and Son, R. (2011) *Salmonella*: A foodborne pathogen. *Int. Food Res. J.*, 18(2): 465-473.
- Shinohara, N.K.S., Barros, V.B., Jimenez, S.M.C., Machado, E.C.L., Dutra, R.A.F. and Lima Filho, J.L. (2008) *Salmonella* spp., importante agente patogênico veiculado em alimentos. *Cien. Saude Colet.*, 13(5): 1675-1683.
- Abd El-Ghany, W.A. (2020) Salmonellosis: A foodborne zoonotic and public health disease in Egypt. *J. Infect. Dev. Ctries.*, 14(7): 674-678.
- Lobna, M.A.S., Maysa, A.I.A., Nashw, O.K. and Marwa, O.A.S. (2017) Zoonotic importance of salmonellosis in chickens and humans at Qalyobia province. *Egypt. J. Vet. Sci.*, 47(2): 151-164.
- Scallan, E., Hoekstra, R.M., Angulo, F.J., Tauxe, R.V., Widdowson, M.A., Roy, S.L., Jones, J.L. and Griffin, P.M. (2011) Foodborne illness acquired in the United States-Major pathogens. *Emerg. Infect. Dis.*, 17(1): 7-15.
- Anderson, T.C., Nguyen, T.A., Adams, J.K., Garrett, N.M., Bopp, C.A., Baker, J.B., McNeil, C., Torres, P., Ettestad, P.J., Erdman, M.M., Brinson, D.L., Gomez, T.M. and Behraves, C.B. (2016) Multistate outbreak of human *Salmonella* Typhimurium infections linked to live poultry from agricultural feed stores and mail-order hatcheries, United States 2013. *One Health*, 2(12): 144-149.
- Hansen-Wester, I. and Hensel, M. (2001) *Salmonella* pathogenicity islands encoding type III secretion systems. *Microbes Infect.*, 3(7): 549-559.
- Lerminiaux, N.A., Mackenzie, K.D. and Cameron, A.D.S. (2020) *Salmonella* pathogenicity island 1 (SPI-1): The evolution and stabilization of a core genomic type three secretion system. *Microorganisms*, 8(4): 1-22.
- Jamshidi, A. (2009) Identification of *Salmonella* spp. and *Salmonella* Typhimurium by a multiplex PCR-based assay from poultry carcasses. *Int. J. Vet. Res.*, 3(1): 43-48.
- Lou, L., Zhang, P., Piao, R. and Wang, Y. (2019) *Salmonella* pathogenicity island 1 (SPI-1) and its complex regulatory network. *Front. Cell. Infect. Microbiol.*, 9(7): 1-12.
- Pham, O.H. and McSorley, S.J. (2015) Protective host immune responses to *Salmonella* infection. *Future Microbiol.*, 10(1): 101-110.
- Abdel-Aziz, N.M. (2016) Detection of *Salmonella* species in chicken carcasses using genus specific primer belong to invA gene in Sohag city, Egypt. *Vet. World.*, 9(10): 1125-1128.
- Yanestria, S.M., Rahmaniar, R.P., Wibisono, F.J. and Effendi, M.H. (2019) Detection of invA gene of *Salmonella* from milkfish (*Chanos chanos*) at Sidoarjo wet fish market, Indonesia, using polymerase chain reaction technique. *Vet. World.*, 12(1): 170-175.
- Malorny, B., Hoorfar, J., Bunge, C. and Helmuth, R. (2003) Multicenter validation of the analytical accuracy of *Salmonella* PCR: Towards an international standard. *Appl. Environ. Microbiol.*, 69(1): 290-296.
- Wibisono, F.J., Sumiarto, B., Untari, T., Effendi, M.H., Permatasari, D.A. and Witaningrum, A.M. (2020) Antimicrobial resistance on *Escherichia coli* from poultry production on Blitar, Indonesia. *Indian J. Forensic Med. Toxicol.*, 14(4): 4131-4136.
- Hale, C.R., Scallan, E., Cronquist, A.B., Dunn, J., Smith, K., Robinson, T., Lathrop, S., Tobin-D'Angelo, M. and Clogher, P. (2012) Estimates of enteric illness attributable to contact with animals and their environments in the United States. *Clin. Infect. Dis.*, 54(5): S472-S479.
- Behraves, C.B., Brinson, D., Hopkins, B.A. and Gomez, T.M. (2014) Backyard poultry flocks and salmonellosis: A recurring, yet preventable public health challenge. *Clin. Infect. Dis.*, 58(10): 1432-1438.
- Wibisono, F.J., Sumiarto, B., Untari, T., Effendi, M.H., Permatasari, D.A. and Witaningrum, A.M. (2020) The presence of extended-spectrum beta-lactamase (ESBL) producing *Escherichia coli* on layer chicken farms in Blitar area, Indonesia. *Biodiversitas*, 21(6): 2667-2671.
- Widodo, A., Effendi, M.H. and Khairullah, A.R. (2020) Extended-spectrum beta-lactamase (ESBL)-producing *Escherichia coli* from livestock. *Syst. Rev. Pharm.*, 11(7): 382-392.
- Harijani, N., Oetama, S.J.T., Soepranianondo, K., Effendi, M.H. and Tyasningsih, W. (2020) Biological hazard on multidrug resistance (MDR) of *Escherichia coli* collected from cloacal swab of broiler chicken on Wet Markets Surabaya. *Indian J. Forensic Med. Toxicol.*, 14(4): 3239-3244.
- Wibisono, F.J., Sumiarto, B., Untari, T., Effendi, M.H., Permatasari, D.A. and Witaningrum, A.M. (2020) CTX gene of extended-spectrum beta-lactamase (ESBL) producing *Escherichia coli* on broilers in Blitar, Indonesia. *Syst. Rev. Pharm.*, 11(7): 396-403.
- Pemkab Blitar. (2018) General Description of Blitar District. Available from: <http://www.blitarkab.go.id>. Retrieved on 14-01-2021.
- Effendi, M.H., Tyasningsih, W., Yurianti, Y.A., Rahmahani, J., Harijani, N. and Plumeriastuti, H. (2021) Presence of multidrug resistance (MDR) and extended-spectrum beta-lactamase (ESBL) of *Escherichia coli* isolated from cloacal swabs of broilers in several wet markets in Surabaya, Indonesia. *Biodiversitas*, 22(1): 304-310.
- Rahn, K., Grandis, S.A., Clarke, R.C., McEwen, S.A., Galan, J.E., Ginocchio, C., Curtiss, R. and Gyles, C.L. (1992) Amplification of an invA gene sequence of *Salmonella* Typhimurium by polymerase chain reaction (PCR) as a specific method for detection of *Salmonella*. *Mol. Cell. Probes*, 6(4): 271-279.
- Rahayuningtyas, I., Astuti, L.S., Istiyaningsih, I., Andesfha, E. and Atikah, N. (2018) Isolation and identification of *Salmonella* sp and *Escherichia coli* for mapping antimicrobial resistance in layer and broiler farms in 5 provinces in Java. In: *Penyidikan Penyakit Hewan Rapat Teknis dan Pertemuan Ilmiah (RATEKPIL) dan Surveilans Kesehatan Hewan Tahun 2018*. p482-494.
- Thaha, A.H. (2016) Clinical description and prevalence of salmonellosis in layer chickens in Tanente village, Kec. Maritigae, Sidrap Regency. *Lab. Basic Anim. J. (Ilmu Peternak Fak. Sains Teknol.)*, 3(1): 160-168.
- Darmawan, A., Muslimin, L., Arifah, S. and Mahatmi, H. (2020) Contamination of *Salmonella* spp in broiler chicken sold in several traditional markets in Makassar. *Indones.*

- Med. Vet.*, 9(2): 168-176.
31. Eng, S.K., Pusparajah, P., Ab Mutalib, N.S., Ser, H.L., Chan, K.G. and Lee, L.H. (2015) *Salmonella*: A review on pathogenesis, epidemiology and antibiotic resistance. *Front. Life Sci.*, 8(3): 284-293.
 32. Magiorakos, A.P., Srinivasan, A., Carey, R.B., Carmeli, Y., Falagas, M.E., Giske, C.G., Harbarth, S., Hindler, J.F., Kahlmeter, G., Liljequist, B.O., Paterson, D.L., Rice, L.B., Stelling, J., Struelens, M.J., Vatopoulos, A., Weber, J.T. and Monnet, D.L. (2012) Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: An international expert proposal for interim standard definitions for acquired resistance. *Clin. Microbiol. Infect.*, 18(3): 268-281.
 33. Rahmahani, J., Salamah, S., Mufasirin, M., Tyasningsih, W. and Effendi, M.H. (2020) Antimicrobial resistance profile of *Escherichia coli* from cloacal swab of domestic chicken in Surabaya traditional market. *Biochem. Cell. Arch.*, 20(1): 2993-2997.
 34. Rahman, S.U., Ali, T., Ali, I., Khan, N.A., Han, B. and Gao, J. (2018) The growing genetic and functional diversity of extended-spectrum beta-lactamases. *Biomed. Res. Int.*, 2018(3): 9519718.
 35. Raini, M. (2016) Fluoroquinolones antibiotics: Benefits and side effects. Vol. 26. In: Pusat Penelitian dan Pengembangan Biomedis dan Teknologi Dasar Kesehatan, Badan Litbangkes, Kemenkes RI. p163-174.
 36. Riwu, K.H.P., Effendi, M.H. and Rantam, F.A. (2020) A review of extended-spectrum β -lactamase (ESBL) producing *Klebsiella pneumoniae* and multidrug-resistant (MDR) on companion animals. *Syst. Rev. Pharm.*, 11(7): 270-277.
 37. Putra, A.R.S., Effendi, M.H. and Kurniawan, F. (2020) Investigation of extended-spectrum beta-lactamase (ESBL) Producing *Escherichia coli* by vitek-2 on dairy cows in Surabaya, Indonesia. *Biochem. Cell. Arch.*, 20(2): 6773-6777.
 38. Wibisono, F.J., Sumiarto, B., Untari, T., Effendi, M.H., Permatasari, D.A. and Witaningrum, A.M. (2020) Prevalence and risk factors analysis of multidrug resistance of *Escherichia coli* bacteria in commercial chicken, Blitar district. *J. Trop. Anim. Vet. Sci.*, 10(1): 15.
 39. Wibisono, F.J., Sumiarto, B., Untari, T., Effendi, M.H., Permatasari, D.A. and Witaningrum, A.M. (2020) Short communication: Pattern of antibiotic resistance on extended-spectrum beta-lactamases genes producing *Escherichia coli* on laying hens in Blitar, Indonesia. *Biodiversitas*, 21(10): 4631-4635.
 40. Sofiana, E.D., Pratama, J.W.A., Effendi, M.H., Plumeriastuti, H., Wibisono, F.M., Hartadi, E.B. and Hidayatullah, A.R. (2020) A review of the presence of antibiotic resistance problems on *Klebsiella pneumoniae* acquired from pigs: Public health importance. *Syst. Rev. Pharm.*, 11(9): 535-543.
 41. Permatasari, D.A., Witaningrum, A.M., Wibisono, F.J. and Effendi, M.H. (2020) Detection and prevalence of multidrug-resistant *Klebsiella pneumoniae* strains isolated from poultry farms in Blitar, Indonesia. *Biodiversitas*, 21(10): 4642-4647.
 42. Sharma, I. and Das, K. (2016) Detection of invA GENE IN ISOLATED *Salmonella* from marketed poultry meat by PCR assay. *J. Food Proc. Technol.*, 7(3): 1000564.
 43. Yulian, R., Narulita, E., Iqbal, M., Sari, D.R., Suryaningsih, I. and Ningrum, D.E.A. (2020) Detection of virulence and specific genes of *Salmonella* sp. indigenous from Jember, Indonesia. *Biodiversitas*, 21(7): 2889-2892.
 44. Li, H., Bhaskara, A., Megalis, C. and Tortorello, M.L. (2012) Transcriptomic analysis of *Salmonella* desiccation resistance. *Foodborne Pathog. Dis.*, 9(12): 1143-1151.
 45. Pardo-Roa, C., Salazar, G.A., Noguera, L.P., Salazar-Echegarai, F.J., Vallejos, O.P., Suazo, I.D., Schultz, B.M., Coronado-Arrazola, I., Kalergis, A.M. and Bueno, S.M. (2019) Pathogenicity island excision during infection by *Salmonella enterica* serovar Enteritidis is required for crossing the intestinal epithelial barrier in mice to cause systemic infection. *PLoS Pathog.*, 15(12): e1008152.
 46. Andhesfha, E., Indrawati, A. and Mayasari, N.L.P. (2019) Identification of Virulent Genes and Antibiotic Resistance Coding Genes in *Salmonella* Enteritidis from Layer and Broiler Farms in Java Island. Institut Pertanian Bogor, IPB Repository, Bogor, Indonesia.
 47. Ansharieta, R., Effendi, M.H. and Plumeriastuti, H. (2021) Genetic identification of shiga toxin encoding gene from cases of multidrug resistance (MDR) *Escherichia coli* isolated from raw milk. *Trop. Anim. Sci. J.*, 44(1): 10-15.
