Jurnal Veteriner pISSN: 1411-8327; eISSN: 2477-5665
Terakreditasi Nasional Peringkat 2, Dirjen Riset dan Pengembangan,
Kemendiktisaintek RI SK No 10/C/C3/DT.05.00/2025, 21 Mar.2025

Juni 2026 Vol. 27 No. 2: 254-261
DOI: 10.19087/jveteriner.2026.27.2.254
online pada http://ejournal4.unud.ac.id/index.php/juvet

Utilization of Rapid Tests in Determining Salmonella Prevalence in Chicken Meat of Traditional Markets in West Sumatra, Indonesia

(PEMANFAATAN UJI CEPAT DALAM PENENTUAN PREVALENSI SALMONELLA PADA DAGING AYAM PASAR TRADISIONAL DI SUMATERA BARAT, INDONESIA)

Engki Zelpina[1]*, Prima Silvia Noor[1], Yurni Sari Amir[1], Suliha[2]

[1]Program Studi Paramedik Veteriner
[2]Laboratorium Kesehatan dan Penyakit Hewan,
Jurusan Peternakan dan Kesehatan Hewan,
Politeknik Pertanian Negeri Payakumbuh,
Jl. Raya Negara, KM 7, Tanjung Pati, Harau,
Lima Puluh Kota, Sumatera Barat, Indonesia 26271
Email: engkizelpina03@gmail.com

ABSTRACT

Salmonella is a major foodborne pathogen responsible for numerous outbreaks of gastroenteritis worldwide and poultry products are recognized as one of its primary reservoirs. The risk of *Salmonella* contamination in chicken meat increases when hygienic practices during slaughtering, processing and marketing are inadequate, especially in traditional markets where temperature control and sanitation are often neglected. Rapid detection methods are crucial to identify contamination early and prevent potential outbreaks. This study was aimed to determine the occurrence of *Salmonella* sp. in chicken meat sold at traditional markets in West Sumatra, Indonesia, using the rapid test method. Sixty-five chicken meat samples were randomly collected from five traditional markets West Sumatera Province of Indonesia. Each sample was pre-enriched in Buffered Peptone Water and analyzed according to the manufacturer's instructions. The presence of *Salmonella* colonies was confirmed by the appearance of blue-green colonies after 20-24 hours of incubation at 41°C. Results showed that 18 out of 65 samples (27,70%) were positive for *Salmonella* sp. indicating that contaminated chicken meat is still commonly found in traditional markets in West Sumatera. These findings highlight the need for improved hygiene management, proper meat handling and regular microbial surveillance in poultry retail environments. The Compact Dry SL method proved to be a simple, rapid and effective tool for routine screening of *Salmonella* contamination, suitable for use in local laboratories to support food safety control programs in developing regions.

Keywords: *Salmonella* sp.; Compact Dry SL; chicken meat; traditional markets; food safety

ABSTRAK

Salmonella adalah patogen bawaan makanan utama yang bertanggung jawab atas berbagai wabah radang saluran pencernaan (gastroenteritis) di seluruh dunia dan produk unggas dikenal sebagai salah satu reservoir utamanya. Risiko kontaminasi *Salmonella* dalam daging ayam meningkat ketika praktik higienis selama penyembelihan, pemrosesan dan pemasaran tidak memadai, terutama di pasar tradisional sebagai akibat kontrol suhu dan sanitasi sering diabaikan. Metode deteksi cepat sangat penting untuk mengidentifikasi kontaminasi sejak dini dan mencegah potensi wabah. Penelitian ini bertujuan untuk menentukan keberadaan *Salmonella* sp. dalam daging ayam yang dijual di pasar tradisional di Sumatera Barat, Indonesia, menggunakan metode uji cepat. Compact Dry SL (Nissui, Jepang). Enam puluh lima sampel daging ayam dikumpulkan secara acak dari lima pasar tradisional di Sumatera Barat. Setiap sampel diperkaya terlebih dahulu dalam *Buffered Peptone Water* dan dianalisis sesuai dengan petunjuk produsen. Keberadaan koloni *Salmonella* diteguhkan oleh munculnya koloni biru-hijau setelah 20-24 jam inkubasi pada suhu 41°C. Hasil penelitian menunjukkan bahwa 18 dari 65 sampel (27,70%) positif *Salmonella* sp. yang menunjukkan bahwa daging ayam yang terkontaminasi masih banyak ditemukan di pasar tradisional Sumatera Barat. Temuan ini menyoroti perlunya peningkatan manajemen kebersihan, penanganan daging yang tepat dan pengawasan mikroba secara berkala di lingkungan pedagang pengecer daging unggas. Metode Compact Dry SL terbukti menjadi alat yang sederhana, cepat dan efektif untuk uji penyaringan rutin kontaminasi *Salmonella*, cocok untuk digunakan di laboratorium lokal guna mendukung program pengendalian keamanan pangan di wilayah berkembang.

Kata-kata kunci: *Salmonella* sp.; Compact Dry SL; daging ayam; pasar tradisional; keamanan pangan

INTRODUCTION

Salmonella is one of the most significant zoonotic foodborne pathogens worldwide, posing a continuous threat to public health and food safety. It is responsible for a substantial proportion of bacterial gastroenteritis cases, leading to millions of illnesses and thousands of deaths annually (Antunes *et al.*, 2016; Scallan *et al.*, 2015). According to the World Health Organization (WHO, 2022), *Salmonella*-related foodborne diseases cause over 150 million infections globally and result in approximately 250,000 deaths each year. The bacterium's ability to survive under diverse environmental conditions and its broad host range make it particularly challenging to control along the food production and distribution chain.

Among various food sources, poultry and poultry-derived products represent one of the most important reservoirs for Salmonella transmission to humans (Nguyen *et al.*, 2020; D'Aoust and Maurer, 2022). Contamination often occurs during critical processing stages, including slaughtering, evisceration, washing, cutting and storage (Yang *et al*., 2020). Poor sanitation, improper handling, and inadequate temperature control allow *Salmonella* to multiply rapidly and persist on carcasses, equipment, and workers' hands (Li *et al*., 2021). In tropical countries such as Indonesia, the warm and humid climate further facilitates bacterial proliferation in fresh meat sold at open-air markets, where hygiene and sanitation practices are often below standard.

In Indonesia, traditional markets remain the predominant venues for the sale of fresh chicken meat due to consumer preference for freshly slaughtered poultry. However, these markets are characterized by minimal infrastructure, limited cold storage and poor sani-

tation facilities (Zelpina and Noor, 2020). Poultry carcasses are typically displayed at ambient temperatures without protective coverings, while meat-handling equipment such as knives and chopping boards are reused without adequate disinfection (Widiastuti *et al.*, 2021). These unhygienic conditions promote cross-contamination between carcasses and utensils, leading to increased microbial loads. Furthermore, environmental contamination such as through contaminated washing water or surfaces plays a crucial role in the persistence of Salmonella within market environments (Fardsanei *et al*., 2017; Hyeon *et al*., 2021).

Previous surveillance in Indonesian wet markets has revealed *Salmonella* prevalence ranging between 15% and 35% in retail chicken meat (Rizaldi and Zelpina, 2023; Sari *et al.*, 2022), indicating ongoing public health challenges. Similar findings have been reported across Southeast Asia, where prevalence rates remain high due to inadequate slaughterhouse hygiene and weak enforcement of food safety regulations (Kariuki *et al.*, 2020; Nguyen *et al.*, 2020). These findings emphasize the necessity of establishing effective monitoring systems that can detect contamination early, especially in local markets with limited access to advanced microbiological facilities.

Rapid and reliable detection of *Salmonella* is crucial for effective foodborne disease control. Traditional microbiological methods, including selective enrichment, isolation on differential media, and biochemical confirmation, though reliable, require several days to yield results (Kobayashi *et al*., 2018). Molecular techniques such as PCR provide faster results but are often expensive and require sophisticated equipment and technical expertise (Lee *et al.*, 2021). Consequently, there is a growing need for simple, affordable, and accurate rapid testing tools that can be applied in regional laboratories.

The chromogenic dry medium for Salmonella detection (Compact Dry SL®, Nissui Pharmaceutical Co., Tokyo, Japan) is one such innovation designed that allows results within 24 hours (Fujikawa and Morozumi, 2006). It combines ease of use, portability, and cost-effectiveness, making it suitable for laboratories in developing regions. Previous studies have validated its efficiency and accuracy in detecting Salmonella from various food matrices (Kobayashi *et al.*, 2018; Kim *et al*., 2022).

Given the persistent threat of Salmonella contamination in Indonesian traditional markets, this study was aimed to determine the prevalence of *Salmonella* sp. in chicken meat sold in West Sumatra using the Compact Dry SL rapid test. Positive samples were further confirmed using *Shigella Salmonella Agar* (SSA) and biochemical tests (Triple Sugar Iron Agar/TSIA and Lysine Iron Agar/LIA). This research provides updated data on *Salmonella* contamination levels, highlights the effectiveness of rapid detection tools, and underscores the need to strengthen food safety monitoring and education for poultry vendors to protect public health in developing regions.

RESEARCH METHODS

Study Area and Sampling

This study was conducted from July to September 2025 in Payakumbuh City and Lima Puluh Kota Regency, West Sumatra, Indonesia. A total of 65 chicken meat samples were randomly collected from five traditional markets. Each sample, consisting of approximately 500 g of chicken breast meat, was placed in a sterile plastic bag and transported in a refrigerator (4°C) to the Animal Health Laboratory, Department of Animal Husbandry and Animal Health, Payakumbuh State Agricultural Polytechnic.

Sample Preparation

Each 25 g meat sample was homogenized with 225 mL Buffered Peptone Water (BPW) and incubated at 37°C for 18–24 hours for pre-enrichment. After incubation, 1 mL of the enrichment broth was inoculated directly onto the Compact Dry SL plate.

Compact Dry SL Rapid Test Procedure

The Compact Dry SL plates (Nissui

Pharmaceutical Co., Ltd., Tokyo, Japan) were used following the manufacturer's instructions. One milliliter of the enrichment broth was dropped onto the center of the Compact Dry SL plate and spread evenly. The plates were incubated at 37°C for 24–48 hours. *Salmonella* colonies were identified by the characteristic blue-green color due to chromogenic substrate reaction. Results were interpreted as positive if blue-green colonies appeared on the plate, and negative if no such colonies were observed.

Biochemical Confirmation

Presumptive *Salmonella* colonies from SSA were subjected to biochemical identification using Triple Sugar Iron Agar (TSIA) and Lysine Iron Agar (LIA). On TSIA, *Salmonella* typically shows a red slant/yellow butt (K/A) with hydrogen sulfide (H_2S) production (blackening), and on LIA, a purple slant/purple butt (positive lysine decarboxylation) with or without H_2S.

Data Analysis

The percentage of positive samples was calculated to determine the prevalence of *Salmonella* contamination. The results were presented descriptively to illustrate contamination rates among markets.

RESULTS AND DISCUSSION

Out of 65 chicken meat samples analyzed, 18 (27.70%) were positive for *Salmonella* sp. based on the Compact Dry SL rapid test (Figure 1). The characteristic blue-green colonies were clearly observed after 24 hours of incubation. Subsequent streaking on SSA yielded colonies typical of *Salmonella* morphology, colorless to transparent colonies with black centers (Figure 1).

Biochemical confirmation on TSIA showed red slant/yellow butt with blackening, while LIA results revealed purple slant and butt, consistent with *Salmonella* biochemical profiles (Figure 1). These findings confirmed that the isolates detected using Compact Dry SL were indeed *Salmonella* sp.

Out of 65 broiler chicken meat samples collected from traditional markets in West Sumatra, 18 samples (27.70%) tested positive for *Salmonella* sp. using the Compact Dry SL rapid test. Characteristic blue-green colonies were clearly visible after 24 hours of incubation, confirming the efficiency of Compact Dry SL for the rapid detection of *Salmonella*. This result indicates that almost one-third of chicken meat sold in traditional markets was contaminated, posing a significant public health concern (Al Sahlany *et al.*, 2022; Li *et al.*, 2023).

The prevalence of *Salmonella* sp. varied among the five markets, ranging from 9.09% to 66.66%, with the highest contamination found in Market 2 (66.66%) and the lowest in Market 3 (9.09%). These variations likely reflect differences in sanitation conditions, carcass handling practices, chicken sources and storage temperature. Similar findings have been reported by Rahman *et al.* (2021) and Okorie-Kanu *et al.* (2023), who noted that traditional markets generally have higher contamination rates compared to modern retail outlets due to the absence of cold-chain facilities, inadequate hygiene and poor waste management.

Biochemical confirmation of the isolates on Triple Sugar Iron Agar (TSIA) showed a red slant and yellow butt with blackening due to H_2S production, while the Lysine Iron Agar (LIA) revealed purple slant and butt, both consistent with the biochemical characteristics of *Salmonella* (Finstad *et al.*, 2020; Al-Tayyar *et al.*, 2022). These findings confirmed that the isolates identified through Compact Dry SL were indeed *Salmonella* sp.

The overall prevalence of 27.70% in this study is comparable to results from other developing countries, such as Bangladesh (31.4%) (Rahman *et al.*, 2021), Nigeria (29.7%) (Okorie-Kanu *et al.*, 2023), and Egypt (26%) (El-Diasty *et al.*, 2022). However, this prevalence is higher than those reported in Japan (<10%) (Abe *et al.*, 2020) and South Korea (<8%) (Cho *et al.*, 2023), where strict food hygiene regulations and efficient cold chain systems significantly reduce the risk of contamination.

Table 1. Occurrence of *Salmonella* sp. in broiler chicken meat obtained from traditional markets in West Sumatra

No	Market	Number of samples	Negative (n)	Positive (n)	Positive percentage
1	Traditional market 1	28	21	7	33.33
2	Traditional market 2	6	2	4	66.66
3	Traditional market 3	11	10	1	9.09
4	Traditional market 4	8	6	2	25
5	Traditional market 5	12	8	4	33.33
	Total (%)	65	47	18	27.70

Figure 1. A. Positive on Compact Dry SL rapid test, B. Colonies *Salmonella* sp. in Shigella Salmonella Agar, C. Triple Sugar Iron Agar and Lysine Iron Agar

These differences emphasize the importance of effective food safety management and regulatory enforcement in reducing *Salmonella* occurrence along the poultry production chain.

Salmonella sp. is one of the most significant foodborne zoonotic pathogens associated with salmonellosis in humans, often linked to undercooked poultry or cross-contamination during food preparation (Jajere, 2019; Koutsoumanis *et al*., 2020). The bacterium's ability to form biofilms, survive under low temperature or desiccation and exhibit antimicrobial resistance enhances its persistence in the poultry processing environment (Chia *et al.*, 2022; Li *et al.*, 2023).

The detection of *Salmonella* in retail chicken meat from traditional markets underscores the need for improved hygiene practices, including the use of clean water, proper sanitation of equipment and training of vendors in food safety. Furthermore, routine monitoring by food safety authorities and the implementation of Hazard Analysis and Critical Control Point (HACCP) systems are recommended to minimize the risk of *Salmonella* contamination in poultry products (EFSA, 2021; Chlebicz and Śliżewska, 2020).

The results of this study also demonstrate that the Compact Dry SL rapid test is a reliable and efficient alternative for detecting *Salmonella* sp. in poultry meat, providing faster results than conventional culture methods. This finding aligns with reports by Yamazaki *et al*. (2020) and Park *et al*. (2021), who confirmed that Compact Dry SL offers high sensitivity and specificity with

reduced analysis time compared to traditional methods such as Most Probable Number (MPN) or PCR based assays.

CONCLUSION

This study confirmed the presence of *Salmonella* sp. in 27.70% of chicken meat samples sold at traditional markets in West Sumatra. The Compact Dry SL method proved to be a reliable, simple and rapid tool for detecting *Salmonella* contamination. Confirmation through SSA isolation and biochemical testing further validated the results.

SUGGESTION

Strengthening hygiene management, cold chain systems, and regular microbial monitoring in traditional markets are essential to enhance food safety and reduce the risk of *Salmonella* transmission to consumers.

ACKNOWLEDGEMENT

The authors would like to express their gratitude to Directorate General of Research and Development, Ministry of Higher Education, Science, and Technology of the Republic of Indonesia, and Payakumbuh State Agricultural Polytechnic for supporting this research through the Penelitian Fundamental Reguler Batch II 2025 (No. 3136/AL.04/2025).

REFERENCES

Abe K, Ishibashi M, Yoshida T, Matsumoto H. (2020). Prevalence and antimicrobial resistance of Salmonella in retail chicken meat in Japan. *Food Control* 115: 107283.

Al Sahlany STG, Al-Saadi HA, Al-Nasrawi MAJ. 2022. Occurrence and antibiotic resistance of Salmonella in poultry meat: A global perspective. *Veterinary World* 15(3): 532–540.

Al-Tayyar IA, Al-Zahrani IS, Alsulami AF. 2022. Identification and characterization of *Salmonella* species isolated from chicken meat in Saudi Arabia. *Saudi Journal of Biological Sciences* 29(4): 2597–2604.

Antunes P, Mourão J, Campos J, Peixe L. 2016. Salmonellosis: The role of poultry meat. *Clinical Microbiology and Infection* 22(2): 110–121. https://doi.org /10.1016 /j.cmi.2015.12.004

Centers for Disease Control and Prevention (CDC). 2023. Salmonella and foodborne disease surveillance. Atlanta U.S. Department of Health & Human Services.

Chia TW, Goh HW, Ong CK, Yuk HN. 2022. Biofilm formation and resistance characteristics of Salmonella enterica in the poultry production environment. *Microorganisms* 10(4): 801.

Chlebicz A, Śliżewska K. 2020. Campylobacter and Salmonella contamination of chicken meat: A review. *Food Reviews International* 36(5): 539–556.

Cho JH, Kim MY, Park SH. 2023. National surveillance of Salmonella in retail chicken in Korea: Trends and antimicrobial resistance. *Frontiers in Microbiology* 14: 1152478.

D'Aoust JY, Maurer J. 2022. Salmonella species. In Doyle MP, Buchanan RL (Eds.), *Food Microbiology: Fundamentals and Frontiers*. (5th ed) Washington DC. ASM Press. Pp. 411–445

El-Diasty EM, El-Diasty MM, Mahfouz NB. 2022. Prevalence and virulence gene profiling of Salmonella isolated from chicken meat and humans in Egypt. *Veterinary World* 15(11): 2702–2710.

European Food Safety Authority (EFSA). 2021. The European Union One Health 2019 Zoonoses Report. EFSA *Journal* 19(2): e06406.

Fardsanei F, Soltan-Dallal MM, Douraghi M, Rahbar M, Zali MR. 2017. Prevalence and characteristics of Salmonella in retail chicken meat and giblets in Iran. *Food Control* 78: 320–324. https://doi.org/10.1016/j.foodcont.2017.03.010

Finstad S, Rosnes JT, Moen B. 2020. Salmonella biochemistry and identifi cation: Methods and interpretation. *Journal of Clinical Microbiology* 58(3): e01245-19.

Fujikawa H, Morozumi S. 2006. Development of a simple dry medium culture plate method for counting bacteria. *Food Microbiology* 23(1): 75–81. https://doi.org/10.1016/j.fm.2005.01.015

Hyeon JY, Park B, Kim HS, Choi C. 2021. Contamination routes and persistence of Salmonella in poultry production environments. *Poultry Science* 100(2): 774–785. https://doi.org/10.1016/j.psj.2020.10.064

Jajere SM. 2019. A review of *Salmonella enterica* with particular focus on pathogenicity and virulence factors, host specificity, and antimicrobial resi-stance. *Veterinary World* 12(4): 504–521.

Kariuki S, Mbae C, Onsare R, Kavai S. 2020. The role of informal markets in Salmonella transmission in developing countries. *Frontiers in Veterinary Science* 7: 568–575. https://doi.org/10.3389/fvets.2020.00568

Kim YJ, Lee HJ, Park SY, Jeong HS. 2022. Evaluation of chromogenic media and rapid tests for Salmonella detection in poultry and seafood products. *Food Analytical Methods* 15(6): 1493–1501. https://doi.org/10.1007/s12161-021-02164-0

Kobayashi T, Oda M, Saito K. 2018. Evaluation of Compact Dry SL for rapid detection of Salmonella in food samples. *Journal of Food Protection* 81(9): 1478–1483. https://doi.org/10.4315/0362-028X.JFP-18-096

Koutsoumanis KP, Allende A, Alvarez-Ordóñez A, Bolton D, Bover-Cid S, Chemaly M, Davies R, De Cesare A, Herman L, Nauta M, Peixe L, Ru G, Simmons M, Skandamis PN, Suffredini E. 2020. Pathogenic bacteria in food: Risk assessment and control strategies. *Food Microbiology* 92: 103593.

Lee JH, Kim S, Park YJ. 2021. Assessment of rapid methods for detecting Salmonella in poultry meat. *Food Analytical Methods* 14(5): 1013–1021. https://doi.org/10.1007/s12161-020-01957-1

Li J, Zhao L, Xu J, Zhang S. 2023. Salmonella enterica in retail poultry meat: Genomic diversity, virulence, and antimicrobial resistance. *International Journal of Food Microbiology* 388: 110053.

Li Y, Zhang S, Wang C, Zhang X. 2021. Hygienic practices and Salmonella contamination in wet markets of Southeast Asia. *Foodborne Pathogens and Disease* 18(3): 145–153. https://doi. org/10.1089/fpd.2020.2849

Nguyen TNM, Nguyen DTA. Dang VC. 2020. Occurrence and antimicrobial resistance of Salmonella in chicken meat in Vietnam. *International Journal of Food Microbiology* 318: 108463. https://doi.org/10.1016/j.ijfoodmicro.2020.108463

Okorie-Kanu CO, Ezenduka EV, Nwanta JA, Okorie-Kanu J. 2023. Prevalence and antimicrobial susceptibility of Salmonella species isolated from poultry in Nigeria. *PLoS One* 18(1): e0279891.

Park SH, Chon JY, Heo, JY. 2021. Evaluation of Compact Dry SL for detection of Salmonella in poultry and meat products. *Food Microbiology* 94: 103654.

Rahman MA, Hossain MN, Islam MF. 2021. Detection of Salmonella spp. in raw chicken meat and ready-to-eat chicken products in Bangladesh. *Foodborne Pathogens and Disease* 18(4): 275–283.

Rizaldi A, Zelpina E. 2023. Determination of the prevalence of *Escherichia coli* and *Salmonella* sp., in chicken breast sold in traditional markets of East Barito Regency, Indonesia. *Journal of Food Safety and Hygiene* 9(1): 45–49.

Sari RA, Rahmadani R, Putra E. 2022. Detection of *Salmonella* and *Escherichia coli* in broiler meat sold at wet markets in Indonesia. *Indonesian Journal of Food Safety* 10(2): 55–62.

Scallan E, Hoekstra RM, Angulo FJ. 2015. Foodborne illness acquired in the Uni-

ted States: Major pathogens. *Emerging Infectious Diseases* 17(1): 7–15. https://doi.org/10.3201/eid1701.P11101

WHO (World Health Organization). 2022. *Global foodborne disease surveillance and prevention strategies*. Geneva: World Health Organization.

Wibisono, Fransiscus J, Putra RA, Hidayat, MF. 2021. Occurrence and molecular detection of Salmonella in poultry meat sold in Indonesian traditional markets. *Indonesian Journal of Veterinary Science* 19(2): 203–212.

Widiastuti D, Hartono S, Pramono D. 2021. Hygiene and sanitation practices in traditional poultry markets in Indonesia. *Asian Journal of Animal and Veterinary Advances* 16(4): 122–129. https://doi.org/10.3923/ajava.2021.122.129

Yamazaki W, Taguchi M, Sugiyama K. 2020. Comparison of Compact Dry SL with conventional culture methods for detection of Salmonella from food samples. *Journal of Food Protection* 83(5): 827–833.

Yang X, Zhang J, Yu S, Wang X. 2020. Prevalence, antimicrobial resistance, and risk factors of Salmonella in retail chicken meat in Asia. *Food Control* 109: 106922. https://doi.org/10.1016/j.foodcont.2019.106922

Yang X, Wu Q, Zhang J, Chen M. 2021. Contamination and cross-contamination of Salmonella in the chicken supply chain: A review. *Comprehensive Reviews in Food Science and Food Safety* 20(6): 5833–5855.

Zelpina E, Noor SM. 2020. Non-typhoid Salmonella causes food-borne diseases: Its prevention and control.: *Wartazoa* 30(4): 221–229. https://doi.org/10.14334/wartazoa.v30i4.2501

Zhang S, Xu P, Li W, Wang L. 2023. Epidemiological and molecular characterization of Salmonella isolated from chicken meat supply chain. *Food Research International* 166: 112632.

Zhao X, Li Z, Wang Y, Lin W. 2022. Antimicrobial resistance and virulence profiles of Salmonella in poultry meat from wet markets. *Frontiers in Veterinary Science* 9: 948731.